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DOE/NASA CONTRACTOR REPORT

DOE/NASA CR-150614

SYSTEM DESIGN PACKAGE FOR IBM SYSTEM ONE SOLAR HEATING AND DOMESTIC HOT WATER

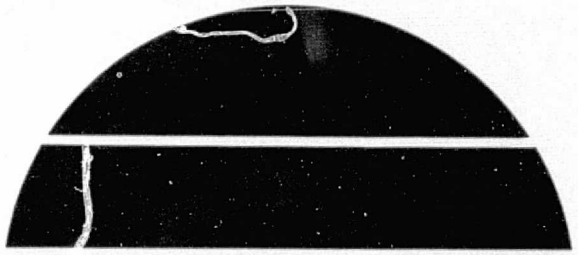
Prepared by

IBM Corporation
Federal Systems Division
150 Sparkman Drive
Huntsville, Alabama 35805

Under Contract NAS8-32036 with

National Aeronautics and Space Administration
George C. Marshall Space Flight Center, Alabama 35812

For the U. S. Department of Energy



(NASA-CR-150614) SYSTEM DESIGN PACKAGE FOR IBM SYSTEM ONE: SOLAR HEATING AND DOMESTIC HOT WATER (IBM Federal Systems Div.) 174 p HC A08/MF A01 CSCL 10A

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Unclas
G3/44 14124

U.S. Department of Energy

Solar Energy

TECHNICAL REPORT STANDARD TITLE PAGE

1. REPORT NO.	2. GOVERNMENT ACCESSION NO.	3. RECIPIENT'S CATALOG NO.
DOE/NASA CR-150614		

4. TITLE AND SUBTITLE	5. REPORT DATE
System Design Package for IBM System One Solar Heating and Domestic Hot Water	February 1977
	6. PERFORMING ORGANIZATION CODE
7. AUTHOR(S)	8. PERFORMING ORGANIZATION REPORT #
9. PERFORMING ORGANIZATION NAME AND ADDRESS IBM Corp, Federal Systems Division 150 Sparkman Drive Huntsville, Alabama 35805	10. WORK UNIT NO. 11. CONTRACT OR GRANT NO. NAS8032036
12. SPONSORING AGENCY NAME AND ADDRESS National Aeronautics and Space Administration Washington, D. C. 20546	13. TYPE OF REPORT & PERIOD COVERED Contractor Report 14. SPONSORING AGENCY CODE

15. SUPPLEMENTARY NOTES

This work was done under the technical management of Mr. Earle G. Harris, George C. Marshall Space Flight Center, Alabama.

16. ABSTRACT

This report is a collation of documents and drawings that describe a prototype solar heating and hot water system using air as the collector fluid and a pebble bed for heat storage. The system was designed for installation into a single-family dwelling. The description, performance specification, subsystem drawings, verification plan/procedure, and hazard analysis of the system are packaged for evaluation of the system with information sufficient to assemble a similar system. The first system (1A) solar heating and domestic hot water is in operation at the Home Builders Association, 2809 Burks Road, SW, Huntsville, Alabama. The second system (1B) is being installed at the U. S. Department of Interior, National Park Service, Carlsbad Caverns, New Mexico, Residence "L."

17. KEY WORDS	18. DISTRIBUTION STATEMENT
	Unclassified-Unlimited William A. Brooksbank WILLIAM A. BROOKSBANK, JR. Manager, Solar Heating and Cooling Project Ofc

19. SECURITY CLASSIF. (of this report)	20. SECURITY CLASSIF. (of this page)	21. NO. OF PAGES	22. PRICE
Unclassified	Unclassified	175	NTIS

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SYSTEM DESCRIPTION

Prototype System 1 has been designed by IBM under contract NAS8-32036 to NASA Marshall Space Flight Center as a solar heating and hot water preheat system for a single family dwelling. The system uses air collectors and a pebble bed storage. Domestic water is preheated with a heat exchanger in the hot air duct.

Figure 1-1 is a pictorial illustration of the system, which was designed for installation on a dwelling in the 1500 to 2500 square foot range. The design can be scaled up or down to accommodate a wide range of heating and hot water requirements for other single family, multi-family or commercial buildings without significant change to the design concept.

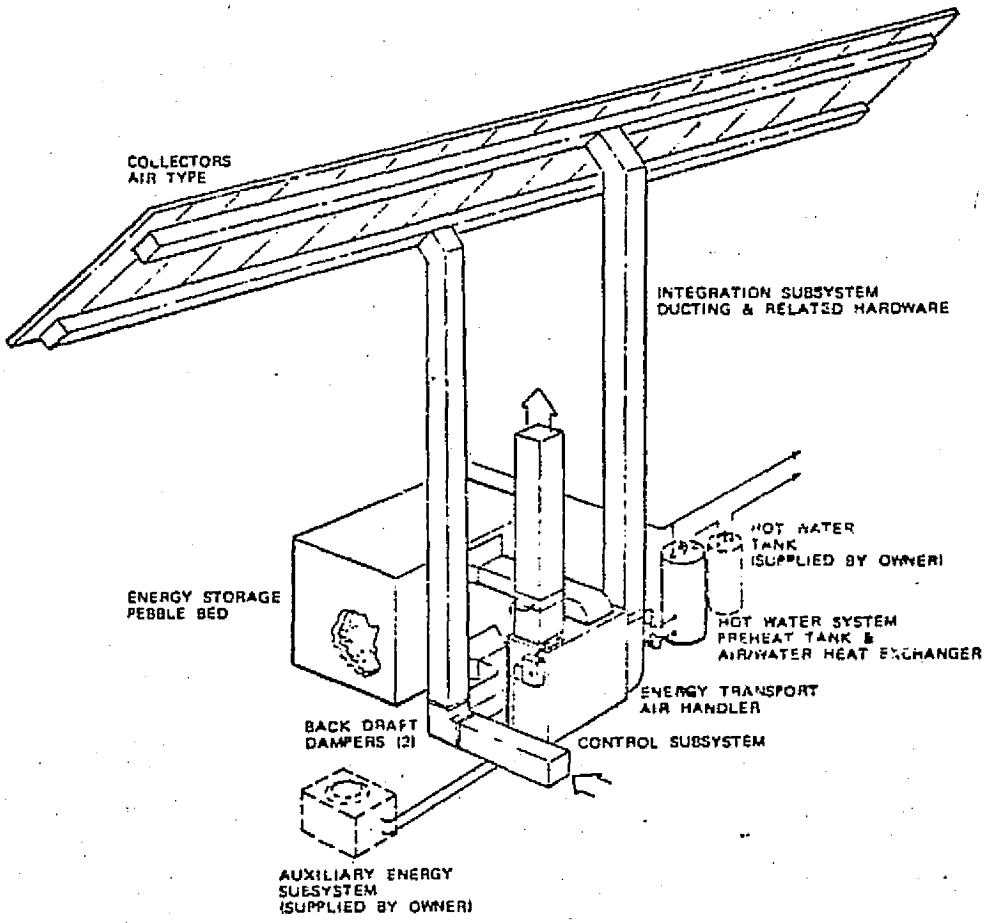

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Figure 1-1. Typical Solar Heating and Hot Water System using Air type collectors.

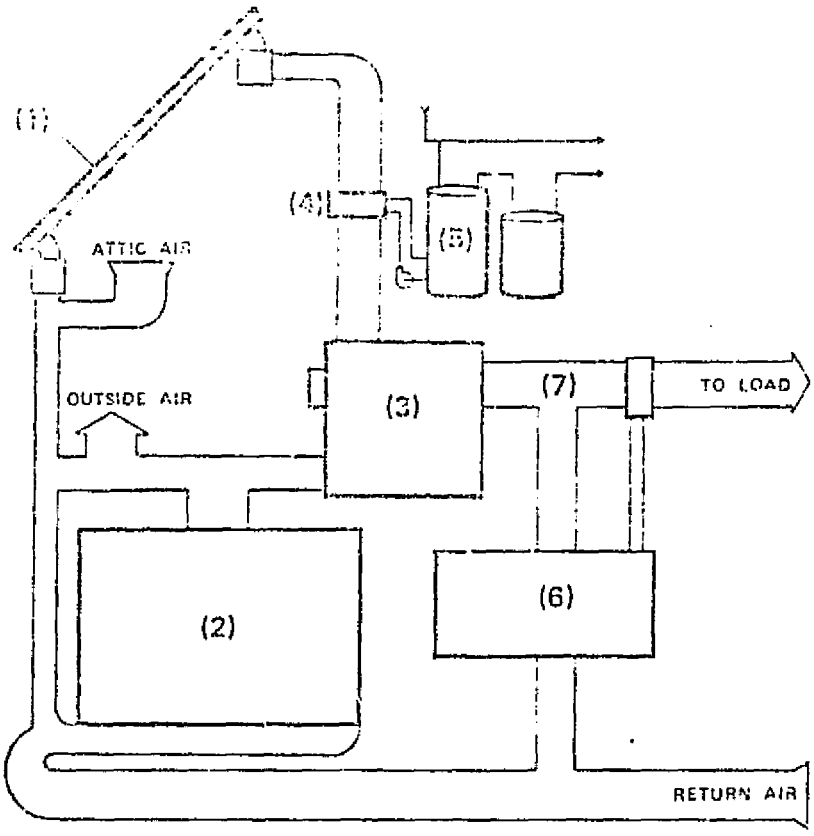

Figure 1-2. Principal Elements of system.

Principal elements of the system are (1) flat plate air type solar collectors, (2) a pebble bed for thermal storage of collected solar energy, (3) an air handling unit to move and direct the air through the energy transport system, (4) an air-to-water heat exchanger and circulating pump to allow for transfer of heat from the collector/storage circuit to the domestic hot water circuit, (5) a domestic hot water pre-heat tank for storage and transfer of collected energy into the conventional domestic water heater, (6) an air-to-air heat pump and electric strip heaters to supply auxiliary energy during periods of insufficient solar insolation, and (7) a ducting system to convey the solar heated air between system components and into the heated space. These elements are shown in Figure 1-2 (above).

IBM SYSTEM 1A

Office Building for the

Home Builders Association of Huntsville, AL

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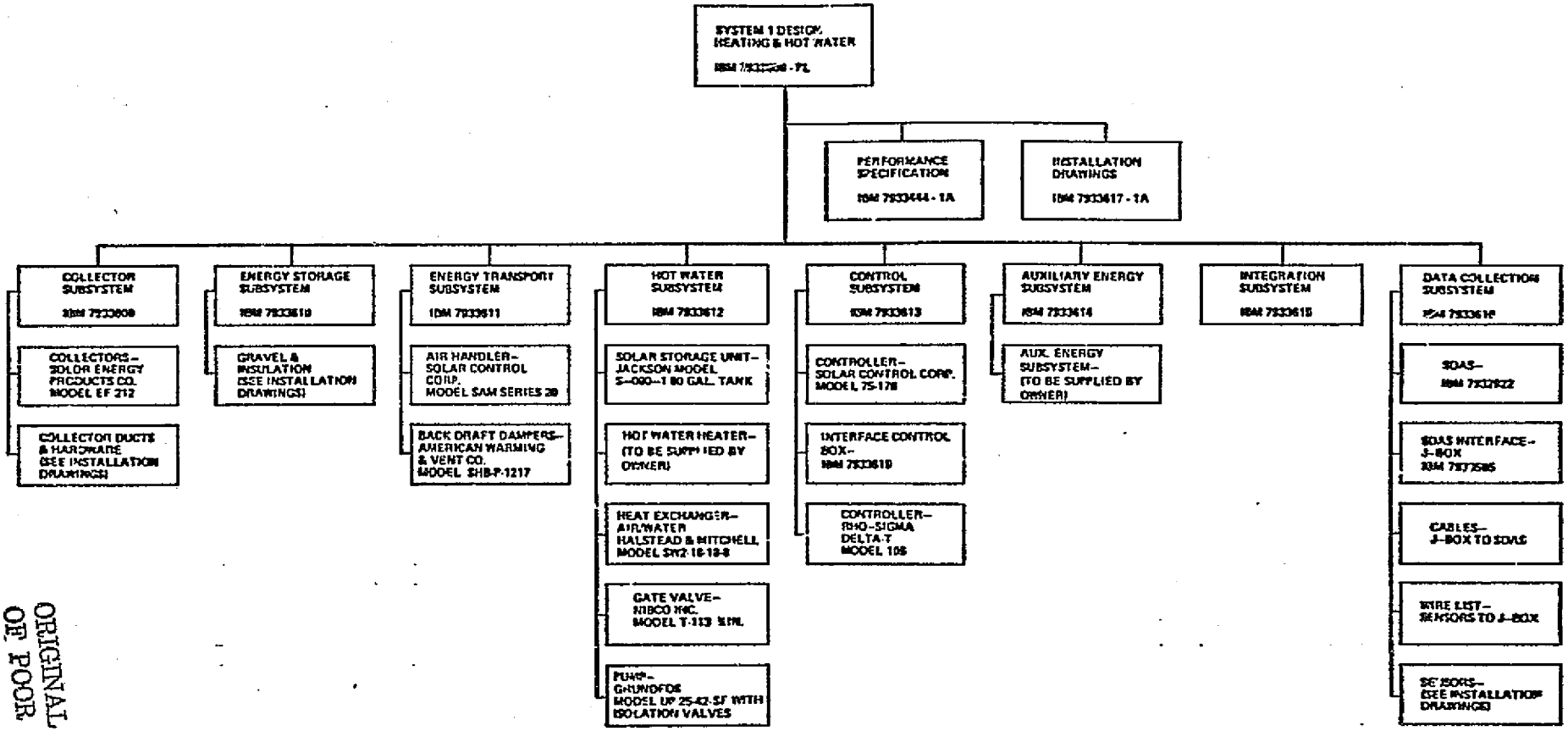
RELEASED FOR ASM	QTY

TECHNICAL APPROVAL				SYM	DATE	CHANGE NO		SYM	DATE	CHANGE NO
ELEC										
METAL										
PLASTIC										

7933608

DEVELOPMENT NO



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SHEET 1 OF 2

IBM MATERIAL	NO
IBM MATL ALTERNATE	NO
CASE DEPTH	
HARDNESS	
SURFACE TREATMENT	

0 1 2
0 25.4 50.8
SCALE NONE
THIRD ANGLE PROJECTION
INCH
m m

MUST CONFORM TO ENG SPEC 890350

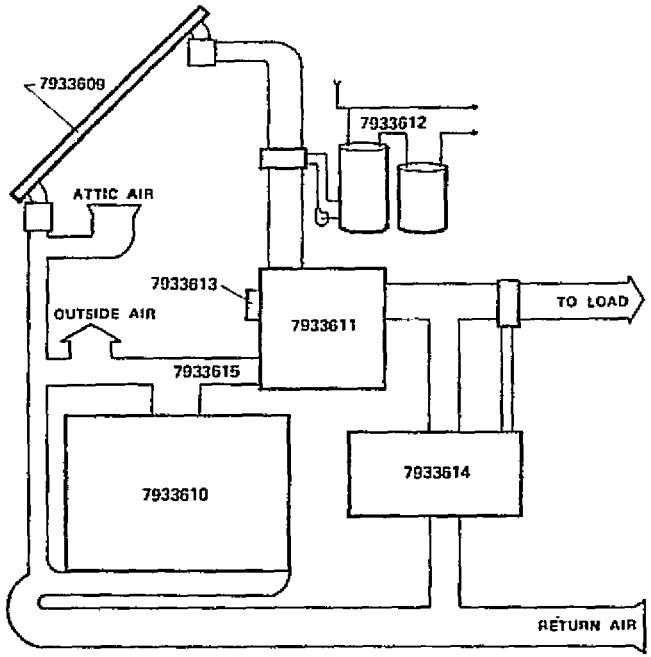
TOLERANCES UNLESS OTHERWISE NOTED		INCH	m m
LINEAR ±			
ANGLES ±			
RADII UNLESS OTHERWISE NOTED			
EDGE CORNER BREAKS	OUTSIDE MAX		
	INSIDE MAX		

IBM

NAME	SYSTEM ONE
DESCRIPTION	
DESIGNER	L CLARK 10/
DETAILER	J PERRY 11/1
DWG CHK	
DSGN APPRO	11/
CLASSIFICATION	

7933608 C

RELEASED FOR ASM	QTY	TECHNICAL APPROVAL				SYM	DATE	CHANGE NO		SYM	DATE	CHANGE NO	7933608
		ELEC											DEVELOPMENT NO
		METAL											
		PLASTIC											



SYSTEM 1 IS A SOLAR HEATING & HOT WATER SYSTEM USING AIR COLLECTORS & ROCK STORAGE WITH AN AIR-TO-WATER HEAT EXCHANGER FOR WATER HEATING.

THE SYSTEM IS COMPRISED OF SEVEN OPERATIONAL SUBSYSTEMS:

COLLECTOR SUBSYSTEM	P/N 7933609
ENERGY STORAGE SUBSYSTEM	P/N 7933610
ENERGY TRANSPORT SUBSYSTEM	P/N 7933611
HOT WATER SUBSYSTEM	P/N 7933612
CONTROL SUBSYSTEM	P/N 7933613
AUXILIARY ENERGY SUBSYSTEM	P/N 7933614
INTEGRATION SUBSYSTEM	P/N 7933615
DATA COLLECTION SUBSYSTEM (NOT SHOWN)	P/N 7933616

SYSTEM PERFORMANCE IS DELINIATED IN THE PERFORMANCE SPECIFICATION, P/N 7933444, WHICH INCLUDES THE INSTALLATION DRAWINGS, P/N 7933617.

IBM MATERIAL	NO	0 1	MUST CONFORM TO ENG SPEC 890350			IBM	
IBM MATL ALTERNATE	NO	0 25.4	TOLERANCES UNLESS OTHERWISE NOTED	INCH	m m	NAME	SYSTEM ONE DESCRIPTION
		SCALE NONE				DESIGNER	
CASE DEPTH			LINEAR ±			DETAILER	11/15/
HARDNESS			ANGLES ±			CWG CHK	
SURFACE TREATMENT			RADII UNLESS OTHERWISE NOTED			DSGN APPRO	
7933608	B	INCH m m	EDGE/CORNER BREAKS OUTSIDE MAX			CLASSIFICATION	
			EDGE/CORNER BREAKS INSIDE MAX				

ARTS IST | IBM | FEDERAL SYSTEMS DIVISION
CODE IDENT 20234 - HUNTSVILLE, AL
CODE IDENT 52088 - MANASSAS VA
CODE IDENT 03640 - OWEGO, NY

CONTRACT NO

CODE *IDENT 20234 | PL 7933608 | REVIS LTR + DATE 08

TITLE

SYSTEM 1 DESIGN HEATING & WATER

EN NO.

SHEET 01

1 REFERENCE DESIGNATION	QUANTITY REQUIRED	UNIT MEAS	CODE IDENT	DRAWING OR DOCUMENT NO	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION
EMS COMMON TO PART NUMBER7933608						
	1	01			7933609	COLLECTOR SUBSYSTEM
	1	01			7933610	ENERGY STORAGE SUBSYSTEM
	1	01			7933611	ENERGY TRANSPORT SUBSYSTEM
	1	01			7933612	HOT WATER SUBSYSTEM
	1	01			7933613	CONTROL SUBSYSTEM
	1	01			7933614	AUX ENERGY SUBSYSTEM
	1	01			7933615	INTEGRATION SUBSYSTEM
	1	01			7933616	SDC SUBSYSTEM-IBM SYSTEM 1

7

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UNIT OF MEASURE CODE
01 = PIECE EACH
11 = INCH
12 = FEET
18 = CUBIC FOOT
31 = OUNCE (AVDP)
35 = OUNCE (TROY)
59 = FLUID OUNCE
66 = CUBIC INCH

SYMBOL CODE (SY): V = VENDOR ITEM. SEE SPECIFICATION OR SOURCE CONTROL DRAWING

PLANNING CODE (PL): K = ALTERNATE ITEM P = BULK MATL (ALL OTHER PL CODES ARE FOR IBM REF ONLY: EG. G = GOVT FURN ITEM J = AS REQD L = DO NOT FILL N = VENDOR FURN R = REF X = DO NOT GENERATE Z = DUMMY CONNECT)

CHARACTER CODE (CH): A = WITH BILL OF MATL D = WITHOUT BILL OF MATL R = FACTORY REF

FORM NO 957-6324-2

CHK	ENGRG NOTICE# LTR	DESCRIPTION	DATE	APPROVED

DWG NO.

CONTR NO. NAS8-32036	INTERNATIONAL BUSINESS MACHINES CORP. FEDERAL SYSTEMS DIVISION HUNTSVILLE, ALA. 35807
PREPARATION [signature] 11/8/76	TITLE SYSTEM PERFORMANCE SPECIFICATION FOR SIMS PROTOTYPE SYSTEM DESIGN NO. 1
DSGN CHK	
DWG CHK	
DSGN APPROVAL [signature] 11/8/76	SIZE A | CODE IDENT NO. | DWG NO. 7933444
	SCALE | WT | SHEET

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2.0 APPLICABLE DOCUMENTS

3.0 APPLICABILITY OF IPC

4.0 DEVIATIONS FROM IPC

5.0 GOVERNMENT FURNISHED PROPERTY

6.0 GOVERNMENT DIRECTED REQUIREMENTS

7.0 GEOGRAPHICAL AREA

8.0 SYSTEM APPENDICES

APPENDIX A

A-0 SYSTEM IDENTIFICATION

A-1 SYSTEM PERFORMANCE

A-2 INSTALLATION DRAWINGS

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1.0 INTRODUCTION

This performance specification establishes the requirements for the design and performance of the solar heating and domestic hot water system utilizing air collectors and a heat pump auxiliary energy subsystem. It designates the Interim Performance Criteria applicable to this type system and defines the deviations. The appendices specify the system performance for each defined site location and system size, the installation drawings, and the detailed configuration diagrams and drawings.

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent specified herein. Specific document reference made in subsequent shall be by basic title or reference number only.

2.1 Government Documents

Interim Performance Criteria for Solar Heating and Combined Heating/Cooling Systems and Dwellings, January 1, 1976, U. S. Department of Housing and Urban Development.

Intermediate Minimum Property Standards for Solar Heating and Domestic Hot Water Systems, April 1976, NBSIR 76-1059, U. S. Department of Housing and Urban Development.

SIMS Contract Statement of Work, NAS8-32036, April 4, 1976 (with current modifications).

2.2 IBM Documents

The following document is referenced for information only:

System One, Description of; 12 November 1976, 7933608.

3.0 APPLICATION OF INTERIM PERFORMANCE CRITERIA BY TYPE OF SYSTEM

The application of each paragraph of the Interim Performance Criteria (IPC) to this type of system is provided in Table I. Since this system provides solar heating and hot water, system type "H" designates the IPC application to this system.

4.0 DEVIATION FROM INTERIM PERFORMANCE CRITERIA

The IPC deviations identified by subsystem evaluation are listed in the following paragraph.

4.1 Deviations to Residential IPC

The collector subsystem evaluation has identified three areas of non-conformance. These IPC requirements are: (1) ultimate load combination (paragraph 3.2.1), (2) resistance to damage (paragraph 3.3.1), and (3) transmission losses due to outgassing (paragraph 5.2.6). No vendor data was available to substantiate these requirements can be met.

4.2 Deviation of Commercial IPC

Not applicable.

5.0 GOVERNMENT FURNISHED PROPERTY

The following items shall be provided by the government:

(1) Collector subsystem: Solar Energy Products Air Collectors (Model No. EF-212).

(2) Differential Thermostat: Rho Sigma (Model No. 106).

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TABLE I

RESIDENTIAL SYSTEMS, INTERIM PERFORMANCE CRITERIA SUMMARY

Sheet 1 of 7

APPLICATION

A - APPLICABLE TO SYSTEMS INDICATED
I - APPLICABLE TO SYSTEM AND BUILDING
NA - NOT APPLICABLE

TYPE SYSTEMS

H - HEATING
HC - HEATING AND COOLING
HW - HOT WATER ONLY

RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEM H	RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEM H
1.1 H and HC System Performance	A	1.3.1 Collector Efficiency	A
1.1.1 Heating Design Temperatures	I	1.4 Thermal Storage	A
1.1.2 Cooling Design Temperatures	NA	1.4.1 Storage Capacity and Rate	A
1.1.3 Relative Humidity and Water Vapor Pressure	I	1.5 Habitability of Occupied Spaces	A
1.1.4 Solar Contribution	A	1.5.1 Heat or Humidity Transfer Effects	I
1.1.5 Operation Impairment	A	1.6 Energy Transport Efficiency	A
1.2 HW System Subsystem Performance	A	1.6.1 Thermal Losses and Electrical Power	A
1.2.1 Water Design Temperature	I	1.7 Control	A
1.2.2 Storage Design Capacity	A	1.7.1 Installation and Maintenance	A
1.2.3 Solar Contribution	A	1.7.2 Manual Adjustment	A
1.2.4 Operational Impairment	A	1.7.3 Inhabited Space Temperature	A
1.3 Collector Performance	A	1.7.4 Hot Water Temperature	A
		1.8 Auxiliary Energy	A
		1.8.1 Design Loads	A

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TABLE I (CONTINUED)

RESIDENTIAL SYSTEMS, INTERIM PERFORMANCE CRITERIA SUMMARY

Sheet 2 of 7

APPLICATION

A - APPLICABLE TO SYSTEMS INDICATED
I - APPLICABLE TO SYSTEM AND BUILDING
NA - NOT APPLICABLE

TYPE SYSTEMS

H - HEATING
HC - HEATING AND COOLING
HW - HOT WATER ONLY

RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEM H	RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEM H
2.1 System Design Conditions	A	2.3 Leakage Prevention	A
2.1.1 Equipment Capabilities	A	2.3.1 Pressure Test Nonpotable Fluids	A
2.1.2 Noise or Erosion-Corrosion	A	2.3.2 Pressure Test: Potable Water	A
2.1.3 Operating Conditions	A	2.3.3 Air Transport Systems	A
2.1.4 Fluid Flow in Collectors	A	2.4 Collector Adjustment	A
2.1.5 Entrapped Air	A	2.4.1 Orientation and Tilt	A
2.1.6 Thermal Expansion of Fluids	A	2.4.2 Mutual Shadowing	A
2.1.7 Pressure Drops	A	2.5 Subsystem Isolation	A
2.1.8 Condensate Removal	NA	2.5.1 Shutdown in Multi-family Housing	A
2.2 Mechanical Stresses	A	2.6 Heat Transfer Fluid Quality	A
2.2.1 Vibration Stress Levels	A	2.6.1 Liquid Quality	A
2.2.2 Vibration from Moving Parts	A	2.6.2 Air Quality	A
2.2.3 Water Hammer	A	2.6.3 Fluid Quality	A
2.2.4 Vacuum Relief Protection	A	2.6.4 Freezing Protection	A
2.2.5 Thermal Changes	A	2.7 Piping Supports	A
2.2.6 Flexible Joints	A	2.7.1 Applicable Plumbing Standards	A

TABLE I (CONTINUED)

RESIDENTIAL SYSTEMS, INTERIM PERFORMANCE CRITERIA SUMMARY

Sheet 3 of 7

APPLICATION

A - APPLICABLE TO SYSTEMS INDICATED
I - APPLICABLE TO SYSTEM AND BUILDING
NA - NOT APPLICABLE

TYPE SYSTEMS

H - HEATING
HC - HEATING AND COOLING
HW - HOT WATER ONLY

RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEM H
2.8 Excessive Pressure and Temperature Protection	A
2.8.1 Relief Valves and Vents	A
3.1 Structural Design Basis	A
3.1.1 Applicable Standards	A
3.1.2 Service Loads	A
3.2 Failure Loads and Load Capacity	A
3.2.1 Ultimate Load Combinations	A
3.2.2 Ice Loads	A
3.2.3 Vehicular Loads	I
3.2.4 Load Capacity	A
3.3 Damage Control	A
3.3.1 Resistance to Damage	A
3.3.2 Glazing Design	A
3.4 Cyclic Loads	A
3.4.1 Deflection Limitations	A
3.5 Cutting of Structural Elements	I
3.5.1 Design Provisions	I
3.6 Creep and Residual Deflection	I
3.6.1 Deflection Limitations	I
3.7 Hail Resistance	A
3.7.1 Hail Size and Loading	A
3.8 Constraint Loads	A
3.8.1 Foundation Settlement	A
3.8.2 Constrain Loads	A
3.9 Ponding Condition	A
3.9.1 Design Provisions	A
4.1 Plumbing and Electrical Installation	A
4.1.1 Plumbing Codes	A
4.1.2 Electrical Codes	A
4.2 Fail-Safe Controls	A
4.2.1 System Failure Prevention	A
4.2.2 Automatic Pressure Relief Valves	A

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TABLE I (CONTINUED)

RESIDENTIAL SYSTEMS, INTERIM PERFORMANCE CRITERIA SUMMARY

Sheet 4 of 7

APPLICATION

A - APPLICABLE TO SYSTEMS INDICATED
I - APPLICABLE TO SYSTEM AND BUILDING
NA - NOT APPLICABLE

TYPE SYSTEMS

H - HEATING
HC - HEATING AND COOLING
HW - HOT WATER ONLY

RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEM H	RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEM H
4.3 Fire Safety	A	4.7 Excessive Surface Temperatures	A
4.3.1 Applicable Fire Standards	A	4.7.1 Protection from Heated Components	A
4.3.2 Penetrations through Fire Rated Assemblies	I	5.1 Effects of External Environment	A
4.4 Toxic	A	5.1.1 Solar Degradation	A
4.4.1 Provisions of Catch Basins	A	5.1.2 Soil Corrosion	A
4.4.2 Detection of Toxic and Flammable Fluids	A	5.1.3 Airborne Pollutants	A
4.5 Safety	I	5.1.4 Dirt Retention on Cover Plate Surface	A
4.5.1 Emergency Egress and Access	I	5.1.5 Abrasive Wear	A
4.5.2 Identification and Location of Controls	A	5.1.6 Fluttering by Wind	A
4.6 Protection and Potable Water and Circulated Air	A	5.2 Temperature and Pressure Resistance	A
4.6.1 Contamination by Materials	A	5.2.1 Thermal Degradation	A
4.6.2 Separation of Circulation Loops	A	5.2.2 Deterioration of Heat Transfer Fluids	A
4.6.3 Backflow Prevention	A	5.2.3 Thermal Cycling Stresses	A
4.6.4 Growth of Fungi	A	5.2.4 Leakage	A
		5.2.5 Deterioration of Gaskets and Sealants	A

RESIDENTIAL SYSTEMS, INTERIM PERFORMANCE CRITERIA SUMMARY

Sheet 5 of 7

APPLICATION

A - APPLICABLE TO SYSTEMS INDICATED
I - APPLICABLE TO SYSTEM AND BUILDING
NA - NOT APPLICABLE

TYPE SYSTEMS

H - HEATING
HC - HEATING AND COOLING
HW - HOT WATER ONLY

RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEM H	RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEM H
5.2.6 Transmission Losses Due to Outgassing	A	6.1.5 Filters	A
5.3 Chemical and Compatibility of Components	A	6.1.6 Potable Water Shutoff	A
5.3.1 Materials/Transfer Fluid Compatibility	A	6.2 Installation, Operation and Maintenance Manual	A
5.3.2 Corrosion of Dissimilar Materials.	A	6.2.1 Installation Instructions	A
5.3.3 Corrosion by Leachable Substnace	A	6.2.2 Maintenance and Operation Instructions	A
5.3.4 Effects of Decomposition Products	A	6.2.3 Maintenance Plan	A
5.4 Components Involving Moving Parts	A	6.2.4 Replacement Parts	A
5.4.1 Wear and Fatigue	A	6.3 Repair and Service Personnel	A
6.1 Accessibility for Maintenance	A	6.3.1 Maintenance of H and HC Systems	A
6.1.1 Access for System Maintenance	A	6.3.2 Maintenance of DHW System	A
6.1.2 Access for System Monitoring	A	7.1 Design	I
6.1.3 Draining and Filling of Liquids	A	7.1.1 Dwelling Design	I
6.1.4 Flushing of Liquids Subsystems	A	7.1.2 Mobile Home Design	I
		7.1.3 Site Design	I
		7.1.4 Passive Use of Solar Energy	I

TABLE I (CONTINUED)

RESIDENTIAL SYSTEMS, INTERIM PERFORMANCE CRITERIA SUMMARY

Sheet 6 of 7

APPLICATION

A - APPLICABLE TO SYSTEMS INDICATED
I - APPLICABLE TO SYSTEM AND BUILDING
NA - NOT APPLICABLE

TYPE SYSTEMS

H - HEATING
HC - HEATING AND COOLING
HW - HOT WATER ONLY

RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEM H	RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEM H
7.2 Adequate Space	I	8.3 Mechanical and Electrical Functioning of Connections	I
7.2.1 Collector Area	I		
7.2.2 Storage Area	I	8.3.1 Plumbing Connections	I
7.2.3 Utility Chases	I	8.3.2 Electrical Connections	I
7.3 Functioning of Dwelling Site	I		
7.3.1 Space Use	I	9.1 Structures Integrity	I
7.3.2 Shading of Adjacent Structures	I	9.1.1 Movement in Adjacent Structures	I
7.3.3 Impact on Environment	I	9.2 Structural Integrity of Dwelling	I
7.3.4 View	I	9.2.1 Loads	I
8.1 Interference with Mechanical Operation	I	9.2.2 Penetration of Structural Members	I
8.1.1 Blockage of Solar Subsystem	I	9.3 Structural Connections	I
8.1.2 Shading of Collector	I	9.3.1 Structural Connections	I
8.1.3 Sensor Location	I		
8.2 Mechanical and Electrical Functioning of Dwelling Site	I	9.3.2 Brittle Subsystem	I
8.2.1 Exhaust and Venting	I	9.3.3 Strength and Stiffness	I
8.2.2 Utilities	I	10.1 Safety of Dwelling and Site	I

TABLE I (CONTINUED)

RESIDENTIAL SYSTEMS, INTERIM PERFORMANCE CRITERIA SUMMARY

Sheet 7 of 7

APPLICATION

A - APPLICABLE TO SYSTEMS INDICATED
I - APPLICABLE TO SYSTEM AND BUILDING
NA - NOT APPLICABLE

TYPE SYSTEMS

H - HEATING
HC - HEATING AND COOLING
HW - HOT WATER ONLY

RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEM H	RESIDENTIAL INTERIM PERFORMANCE CRITERIA PARAGRAPH	TYPE SYSTEM H
10.1.1 Fire	I	12.2.1 Accessibility	I
10.1.2 Accidents	I	12.2.2 Ice Dams	I
11.1 Durability	I	12.3 Connections	I
11.1.1 Vegetation	I	12.3.1 Accessibility	I
11.2 Durability and Reliability of Dwelling and Site	I	13.1 Visual Characteristics of Dwelling and Site	I
11.2.1 Chemical Corrosion	A	13.1.1 Dwelling	I
11.2.2 Heat and Moisture	I	13.1.2 Neighborhood	I
11.2.3 Exterior Penetrations	I		
11.3 Durability and Reliability of Connections	A		
11.3.1 Material Compatibility	A		
12.1 Maintainability of H, HC, HW Systems	I		
12.1.1 Accessibility	I		
12.1.2 Misuse	I		
12.1.3 Permanent Maintenance Accessories	I		
12.2 Maintainability of Dwelling and Site	I		

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6.0 GOVERNMENT DIRECTED REQUIREMENTS

The following requirements are specified in NAS8-32036 and by verbal direction from the contract officer;

(a) IBM shall deliver two identical systems of the following type:

- Single Family Building
- Solar Space Heating and Domestic Hot Water
- Direct Air System (Air Collector)
- Electric Furnace or Heat Pump Auxiliary

(b) All hardware and subsystems, except collectors, and the Rho Sigma differential thermostat shall be purchased by IBM to good commercial practices as off-the-shelf hardware.

(c) Collector and pebble bed sizing may be adjusted for each specific site.

7.0 GEOGRAPHICAL AREA

This heating and hot water system is designed for a single family residence located in the United States. Areas of application include all regions of the U.S. except the extreme north, and regions with low heating degree days, such as Southern California and Florida.

7.1 Typical Geographical Locations

The system design accommodates variation in insolation and heating degree day ranges as follows:

Mean Daily Insolation (Typical Winter Mean)	625 to 1475 BTU/Ft^2
Yearly Heating Degree Days	2000 to 6500

Typical Standard Metropolitan Statistical Areas (SMSA's) within these ranges are:

- Nashville, TN
- Salt Lake City, Utah
- Kansas City, MO
- Los Angeles, CA
- Atlanta, GA
- Las Vegas, NV
- Boston, MA
- Charleston, SC
- Pittsburg, PA
- Detroit, MI
- Wichita, KA
- El Paso, TX

The system application may be extended to other geographical ranges, however, to achieve the optimum performance air handler capacity and/or duct sizes may be impacted.

APPENDIX A

A-0 SYSTEM IDENTIFICATION

This Appendix defines the performance configuration and installation drawings for JIMS Prototype Heating and Hot Water System, IBM Corporation, System Model Number 1A.

A-1 SYSTEM PERFORMANCE SHEETS

Site -

The system shall be installed in a small business office in the city of Huntsville, county of Madison, state of Alabama. This location has a design daily average insolation (typical winter mean) of 770 BTU/Ft^2 and 3300 heating degree (°F) days (typical annual).

Heating Capacity

The system will provide solar energy for 58 percent of the total heating load during the heating season based on an average annual heating load of 65.8 X 10^6 BTU and a peak heating load of 41,250 BTU/Hr.

Cooling Capacity

The system will provide solar energy for N/A percent of the average total cooling during the cooling season, based on an average total cooling load of N/A BTU/Month and a peak cooling load of N/A BTU/Hr.

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Auxiliary Energy

The average annual rate of auxiliary energy supplied to the heating and hot water load shall be no greater than 31.8×10^6 BTU. This shall be no greater than 42 percent of the total energy required for heating and hot water. The average rate of auxiliary energy used for cooling during the cooling season shall be no greater than N/A BTU/Month. This shall be no greater than N/A percent of the total energy required for cooling.

Hot Water

Fifty-two gallons of potable (or usable) hot water shall be delivered at no less than 1.2 gal/min at temperatures no less than 140°F. Recovery time shall be no greater than 0.9 hours. The average hot water heating load will be 0.9×10^6 BTU/Month of which 43 percent is provided by auxiliary energy.

Operating Requirements

The maximum electrical energy required to drive the solar portion of the system at its rated capacity shall be no greater than 1.0 K.W. The maximum electrical energy required to drive the complete system shall be no greater than 28 K.W. The average yearly electrical energy required to drive the system shall be no greater than 6700 K.W.H. Water requirements for cooling condensers and/or air humidification shall be no greater than N/A gal/hr.

Physical Data - Table III

The following subsystems shall have:

	Design life no less than	Weight (filled) no greater than	Installation* dimensions
Heating	20 years	N/A lbs	
Cooling	N/A years	N/A lbs	
Auxiliary Energy	20 years	600 lbs	
Storage	20 years	50000 lbs	
Potable Water (or usable)	10 years	1500 lbs	
Collector	20 years	2000 lbs	
Energy Transport	20 years	130 lbs	
Controls	20 years	40 lbs	

*See Installation Drawings

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DWG NO. 7933609

REVISIONS

CHK	ENGRG NOTICE	LTR	DESCRIPTION	DATE	APPROVED

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CONTR NO.	INTERNATIONAL BUSINESS MACHINES CORP. FEDERAL SYSTEMS DIVISION HUNTSVILLE, ALA. 35807
PREPARATION D. S. Linton 10/29/76	TITLE COLLECTOR SUBSYSTEM SPECIFICATION
DSGN CHK M. A. Strickland 11-4-76	
DWG CHK	
DSGN APPROVAL J. Kracke 11-4-76	SIZE A | CODE IDENT NO. 20234 | DWG NO. 7933609
	SCALE | WT | SHEET

955-1685-0

1.0 SCOPE

1.1 This specification describes the design and fabrication requirements for the System 1A Collection Subsystem.

2.0 APPLICABLE DOCUMENTS

2.1 The following documents form a part of this specification unless otherwise specified herein:

Interim Performance Criteria for Solar Heating and Combined Heating/Cooling Systems and Dwellings, January 1, 1976, U. S. Department of Housing and Urban Development.

Intermediate Minimum Property Standards for Solar Heating and Domestic Hot Water Systems, NBSIR 76-1059, April 1976.

3.0 REQUIREMENTS

3.1 General. The collector subsystem shall be designed and fabricated in accordance with the requirements of the aplicable documents of 2.1 and the requirements as specified herein. The collector subsystem as shown in Figures 1 and 2 consists of the following items:

Solar Collectors

Feeder Ducts

Manifold Ducts

Installation Hardware

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3.1.1 Fire safety. All materials used to install and insulate the collector subsystem shall meet the fire hazard requirements of the IPC. Materials shall have a flame-spread rating not over 25 and a smoke developed rating not higher than 50 per ASTM E84, UL 733. Duct tape shall not be more combustible than approved flame proofed fabric.

3.1.2 Toxic materials. All materials used to install and insulate the collector subsystem shall not emit toxic gases when exposed to temperature up to 250°F.

3.1.3 Corrosion. Materials used to install and insulate the collector subsystem shall be selected so that their performance will not be affected by corrosion over the 20 year life of the system.

3.1.4 Thermal environment. Materials used to install and insulate the collector subsystem shall be capable of withstanding temperatures from -10 to 250°F without deterioration.

3.2 Solar collectors. Model EF212 solar collectors manufactured by Solar Energy Products Company shall be government furnished. The quantity of collectors is site dependent and shall be as specified in the particular system installation drawing. Collectors shall be mounted to rafters. The rafters shall be boxed-in to provide support for the collector on all four sides. The plane of the collector mounting flange shall face south ± 5 degrees and shall be inclined to the horizontal at an angle which is equal to the sum of the site latitude plus 10 degrees with a tolerance of ±5 degrees. Collector installation shall be such as to preclude roof leakage.

Appendix A may be used as an installation design guide.

3.3 Feeder ducts. The feeder ducts shall connect the collectors to the inlet and outlet manifolds ducts. The feeder ducts shall be 6 inches in diameter and shall be installed in such a manner that the joints at the collector and the manifold duct can be visually inspected. The lengths of the inlet and return feeder ducts shall be made equal and be as short as practical to balance air flow to collectors and minimize head loss.

3.4 Manifold ducts. Groups of collectors shall be manifolded together for parallel air flow with an air flow volumetric flow variation between collectors in any one group being less than 5 percent. When more than one set of manifold ducts (inlet and outlet) are used to service the collectors, air flow shall be proportioned so that the volumetric flow variation between any two collectors in the overall system is less than 10 percent. The maximum average air velocity through any portion of the manifold ducts shall be 600 FPM.

3.5 Duct interfaces. The collector-feeder duct, feeder duct-manifold duct and manifold duct-main duct interfaces shall be designed to minimize air leakage and head losses. Duct tape and sealants shall be used where necessary to minimize air leakage.

3.5.1 Collector-feeder duct interface. The attachment hardware shall be used at the collector-feeder duct interface so that mechanical stresses are distributed away from the openings in the collector to the back side of the collector. The attachment hardware shall not protrude into the collector beyond the rear inside surface of the collector and it shall also insure that the feeder duct does not protrude beyond this surface.

3.5.2 Feeder duct-manifold duct interface. The 6 inch duct take-offs used at the feeder duct-manifold duct interface shall minimize head loss and air leakage.

3.6 Insulation.

3.6.1 Collector insulation. The back side of the collector in the area formed by the boxed-in rafters shall be insulated with a material having a R = 10.5 (3 1/2 inch fiber glass, 1 #/ft^3 or equivalent).

3.6.2 Duct insulation. Feeder and manifold ducts shall be insulated with a material having a R = 16.5 (5 1/2 inch fiber glass, 1#/ft^3 or equivalent).

3.7 Installation hardware.

3.7.1 Duct hangers. Manifold ducts shall be suitably installed with hangers to minimize stresses within the ducts and at duct joints to prevent separation and leakage. Feeder ducts shall also be supported with hangers if attachments at the collector and manifold ducts are not adequate to preclude separation and leakage.

3.7.2 Duct sealing material. All duct joints and interfaces shall be tight. Duct tape or suitable sealant shall be applied at joints to eliminate leakage.

3.7.3 Collector mounting hardware. Collectors shall be secured to rafters and close-outs with 2 inch long No. 10 round head or pan head wood screws or equivalent. Screws shall be suitably spaced to secure the collectors to the roof and maintain the seal between collectors. Mounting screws shall be selected and installed so as to minimize electrochemical corrosion.

3.7.4 Insulation attachment hardware. Collector insulation shall be attached to the ducting with staples, tape and/or straps so that the insulation will be kept in contact with the ducting throughout the life of the system. The insulation shall not be excessively compressed so as to lower the thermal resistance of the insulation.

3.7.5 Flashings. Flashing material shall be selected so as to minimize corrosion when exposed to weather and when in contact with the collector where electrochemical corrosion is possible.

3.7.6 Sealant. A non-hardening sealant shall be used to maintain a water-tight seal between collector flanges and between collector flanges and flashings. A sealant/adhesive shall also be used at the collector-feeder duct interface to bond interface hardware to the collector.

APPENDIX A

A. PREPARATION OF THE ROOF

1. Trusses or rafters must be located on 24" centers. The length of rafters or trusses must be greater than 12 feet.

2. The length of the rough opening required for each solar panel is 144".

3. Material of the same cross-section of the rafter is nailed in place between the rafters at each end to form a rough opening box.

4. Sheathing is applied to the remaining area of the roof. Strips of sheathing must be nailed along the top of the rafters where the panels are to be located. This forms a flush mounting surface all around the SOLORON panel.

5. Roofing felt is applied to cover the sheathing up to the panel opening.

6. Apply roof shingles to the lower portion of the roof up to within 2-3" of the lower edge of the rough opening.

7. Nail in place, in a bed of roofing cement, or high quality non-hardening sealant, aluminum flashing along the entire lower edge of the rough opening.

B. SETTING AND SEALING THE PANELS

1. Apply a non-hardening sealant bed all around the edge of the first rough opening (either the extreme left or right hand opening).

2. Set the first solar panel in place making sure that there are no gaps in the sealant and that the panel is properly seated.

3. Drill clearance holes for 2 inch No. 10 round or pan head wood screws through aluminum flanges on the bottom and one side of the panel (the left side if the first panel is on the left, the right side if the first panel is on the right). The holes should be located approximately 12" apare on all three sides.

4. Screw down the two sides with 2 inch No. 10 wood screws.

5. Apply high quality non-hardening sealant all around the opening to receive the next panel. Make sure there are no gaps in the sealant especially where the flanges of the adjacent collectors overlap.

6. Drill clearance holes through the overalpping flange and the bottom flanges and screw down the two sides of the collector.

7. Repeat steps 1 through 6 for the remaining collectors.

8. Apply 10" wide aluminum flashing in a bed of roof cement or high quality non-hardening sealant on the top flange of the panels.

9. Drill clearance holes for 2" No. 10 wood screws through the flashing and flange along the top edge of the panels and screw down.

10. Apply roof cement or high quality non-hardening sealant bed along extreme left and right flanges of the panels.

11. Apply roofing shingles right up to the top of the panel along both extreme sides of the panel system.

12. Complete by applying shingling along top edge of the collector up to the ridge of the roof.

13. It may be desirable to check out the leak-tightness of the installation by hosing water over all the collectors and joints.

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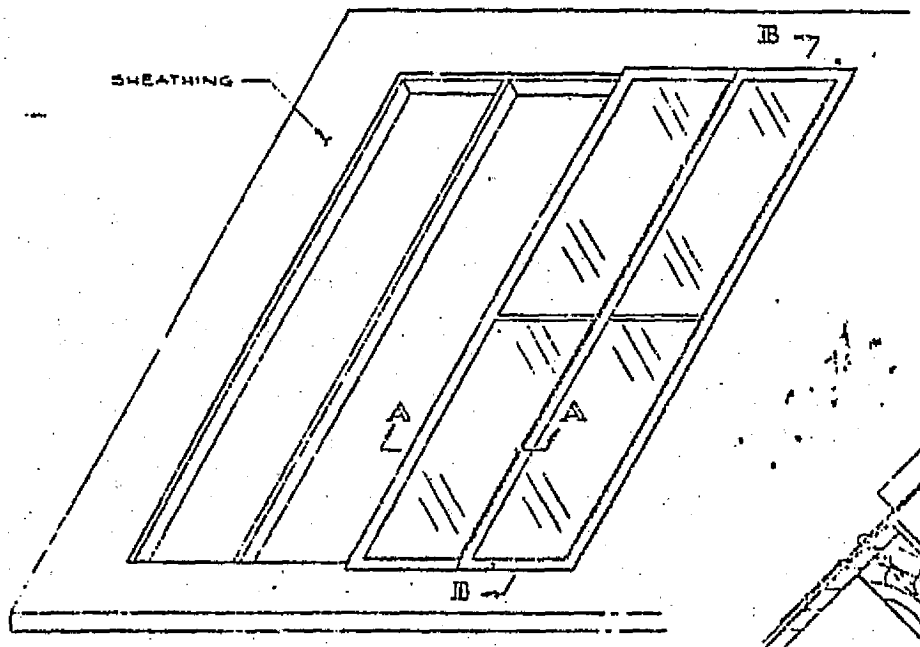
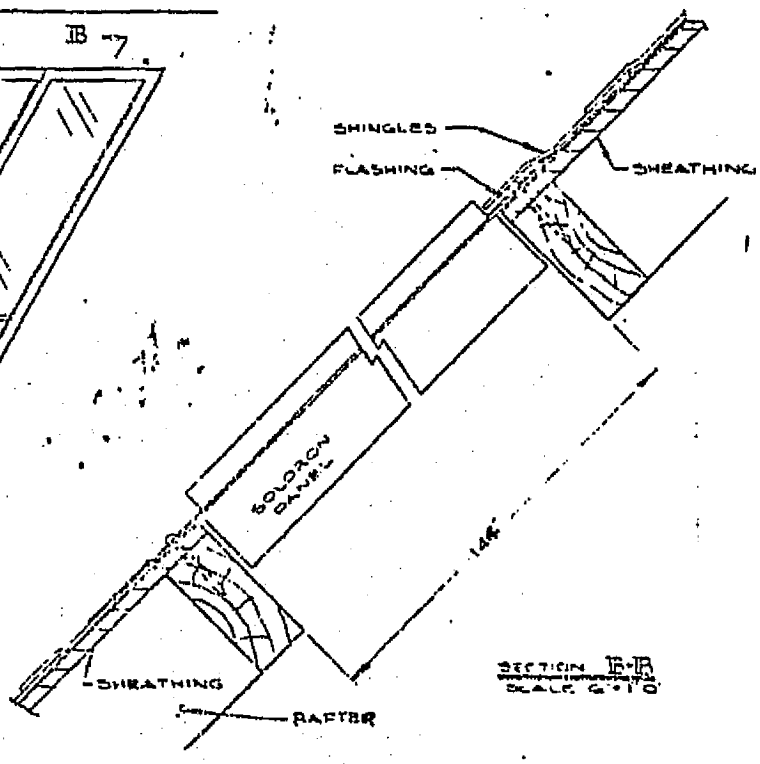
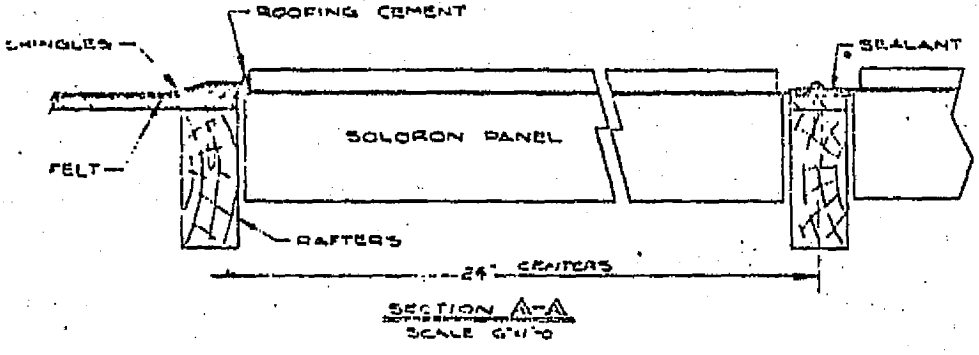


TYPICAL VIEW SHOWING OPENINGS FOR PANELS & WITH PANELS IN PLACE
SCALE 3/4"=1'-0"



SECTION B-B
SCALE 6"=1'0"



SECTION A-A
SCALE 6"=1'-0"

USE #6 x 2"LG ROUND HEAD OR PAN HEAD WOOD SCREWS WITH SEAL UNDER THE HEAD EVERY 12" ON EACH SIDE AND ENDS. DRILL CLEARANCE HOLES THROUGH ALUM. FLANGES WHEN IN PLACE.

SOLOR ENERGY PRODUCTS
121 MILLER ROAD
AVON LAKE, OHIO

INSTALLATION OF MODEL SE-21C DROP IN SOLAR AIR HEATER

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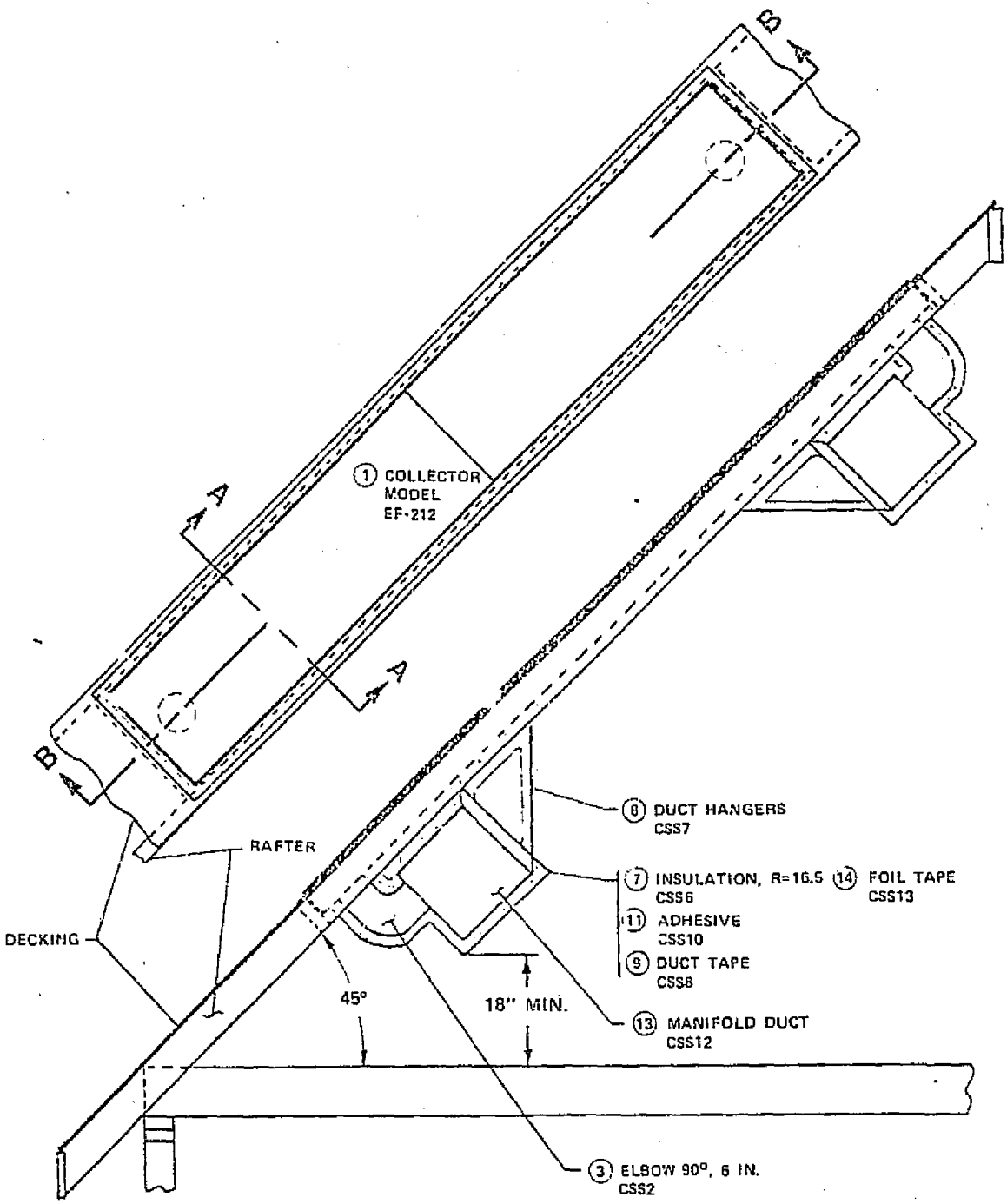
B
A
A
B
1 COLLECTOR MODEL EF-212
8 DUCT HANGERS CSS7
7 INSULATION, R=16.5 CSS6
14 FOIL TAPE CSS13
11 ADHESIVE CSS10
9 DUCT TAPE CSS8
13 MANIFOLD DUCT CSS12
RAFTER
DECKING
45°
18" MIN.
3 ELBOW 90°, 6 IN. CSS2

Figure 1

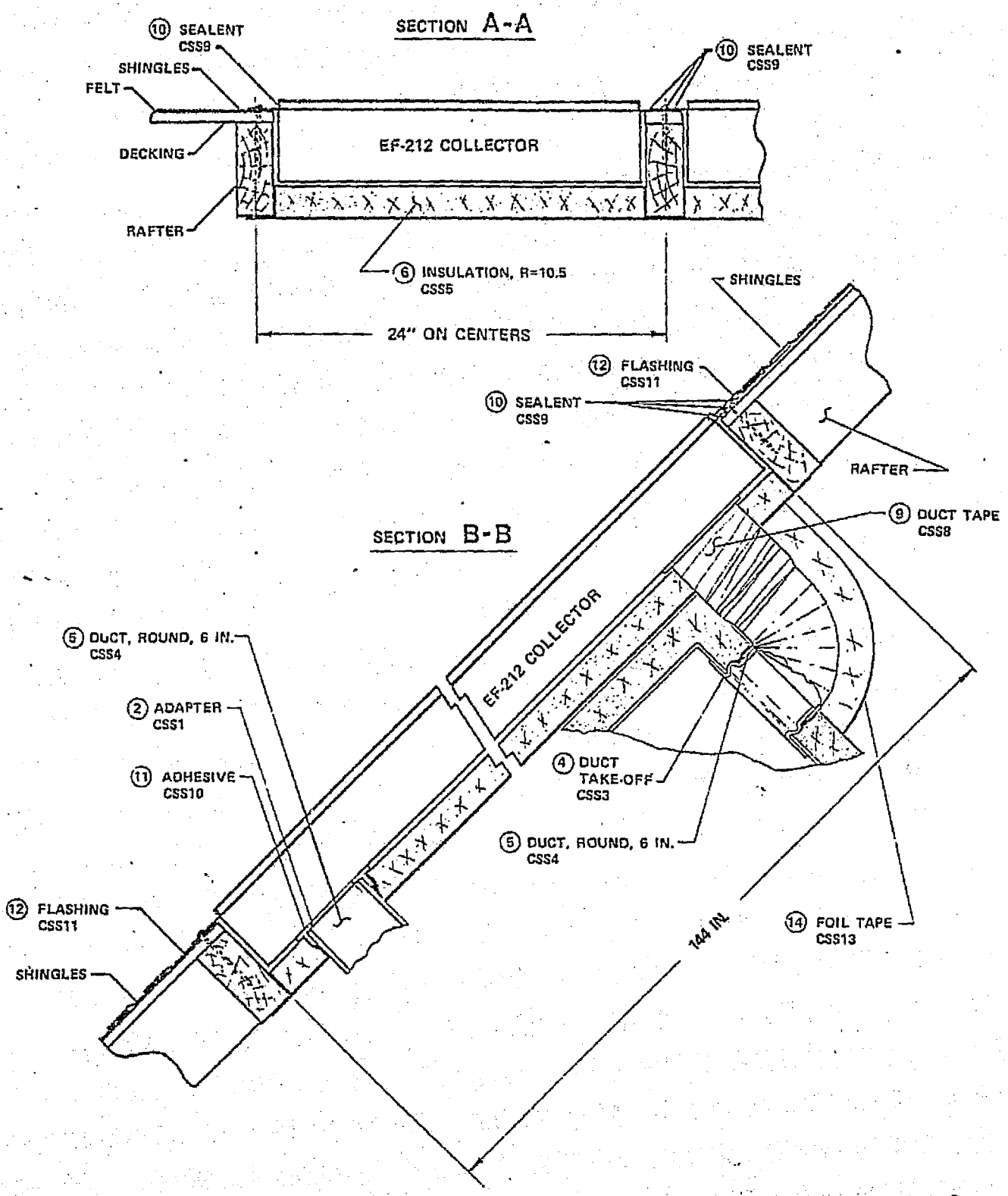

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Figure 2

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FEDERAL SYSTEMS DIVISION
CODE IDENT 20234 – HUNTSVILLE, AL
CODE IDENT 52088 – MANASSAS, VA
CODE IDENT 03640 – OWEGO, NY

CONTRACT NO.

CODE * IDENT 20234 | PL 7933609

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DATE 08D

)LLECTOR SUBSYSTEM

EN NO.

SHEET 01

REFERENCE DESIGNATION	QUANTITY REQUIRED	UNIT MEAS	CODE IDENT	DRAWING OR DOCUMENT NO	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION
; COMMON TO PART NUMBER7933609						
	30	01			MODELFF212	COLLECTOR
	60	01			CSS1	ADAPTER (COLLECTOR TO DUCT)
	60	01			CSS2	ELBOW 90 DEG 6 IN
	AR				CSS3	DUCT TAKE OFF 6 IN
	AR				CSS4	DUCT ROUND 6 IN
	AR				CSS5	INSULATION R-10.5
	AR				CSS6	INSULATION R-16.5
	AR				CSS7	DUCT HANGARS
	AR				CSS8	DUCT TAPE
	AR				CSS9	SEALANT
	AR				CSS10	ADHESIVE
	AR				CSS11	FLASHING
	AR				CSS12	MANIFOLD DUCT
	AR				CSS13	FOIL TAPE

C-10

OF MEASURE CODE
= PIECE EACH
= INCH
= FEET
= CUBIC FOOT
= OUNCE (AVDP)
= OUNCE (TROY)
59 = FLUID OUNCE
66 = CUBIC INCH

SYMBOL CODE (SY): V = VENDOR ITEM. SEE SPECIFICATION OR SOURCE CONTROL DRAWING

PLANNING CODE (PL): K = ALTERNATE ITEM P = BULK MATL (ALL OTHER PL CODES ARE FOR IBM REF ONLY: EG. G = GOVT FURN ITEM J = AS REQD
L = DO NOT FILL N = VENDOR FURN R = REF X = DO NOT GENERATE Z = DUMMY CONNECT)

CHARACTER CODE (CH): A = WITH BILL OF MATL D = WITHOUT BILL OF MATL R = FACTORY REF

DWG NO. 7933610

REVISIONS

CHK	ENGRG NOTICE	LTR	DESCRIPTION	DATE	APPROVED

CONTR NO.	
PREPARATION	11/22/76
DSGN CHK	11/23/76
DWG CHK	
DSGN APPROVAL	11-23-76

INTERNATIONAL BUSINESS MACHINES CORP.
FEDERAL SYSTEMS DIVISION
HUNTSVILLE, ALA. 35807

TITLE
ENERGY STORAGE SUBSYSTEM
SPECIFICATION

SIZE	CODE IDENT NO.	DWG NO.
A	20234	7933610

SCALE	WT	SHEET

955-1685-0

1.0 SCOPE

This specification describes the design, fabrication and installation requirements for the System 1 Energy Storage Subsystem which are necessary for proper system performance.

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this specification unless otherwise specified herein:

Interim Performance Criteria Commercial Solar Heating and Combined Heating/Cooling Systems and Facilities

Interim Performance Criteria for Solar Heating and Combined Heating/Cooling Systems and Dwellings

Intermediate Minimum Property Standards for Solar Heating and Domestic Hot Water Systems

3.0 REQUIREMENTS

3.1 GENERAL

The energy storage subsystem shall be designed, fabricated and installed in accordance with the requirements of the Interim Performance Criteria and HUD minimum property standards for Solar Systems and the requirements as specified herein. The energy storage subsystem consists of the following items:

- Pebble bed
- Grating
- Lower plenum chamber and grating support
- Upper plenum chamber
- Container

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3.1.1 Fire Safety. All materials used to install and insulate the energy storage subsystem shall meet the fire hazard requirements of the IPC. Materials shall have a flame-spread rating not over 25 and a smoke developed rating not higher than 50 per ASTM E84, UL 733.

3.1.2 Toxic Materials. All materials used to install and insulate the energy storage subsystem shall not emit toxic gases when exposed to temperature up to 250°F.

3.1.3 Corrosion. Materials used to install and insulate the energy storage subsystem shall be selected so that their performance shall not be affected by corrosion over the 20 year life of the system.

3.1.4 Thermal Environment. Materials used to install and insulate the energy storage subsystem shall be capable of withstanding temperatures from -10 to 250°F without deterioration.

3.2 PEBBLE BED

3.2.1 Pebble Selection

The pebbles used in the bed shall be washed to remove dirt, sand and other foreign matter to insure maximum heat transfer characteristics. The type and size requirements are as follows:

Type:	Relatively smooth, rounded pebbles, such as, river stones.
Nominal Size:	The mean size of the pebbles shall fall within the range of 1/2 to 2 inches.
Relative Pebble Size:	Pebbles of approximately the same size shall be utilized to insure adequate air flow. Relative pebble size variations shall be controlled so that the maximum pressure drop across the bed is not exceeded. (See paragraph 3.2.2.2)

3.2.2 Bed Size. The size of the pebble bed shall be within the architectural constraints of the building and the requirements and limitations identified herein.

3.2.2.1 Thermal Storage Capacity/Volume. The volume of the bed shall be such that the thermal storage capacity is 15 ± 5 BTU/^{o}F/Ft^{2} collector.

Note:

This thermal capacity is equivalent to 3/4 ± 1/4 cubic foot of pebbles per square foot of collector area. One cubic foot of pebbles weighs approximately 100 pounds. Each collector panel contains 19.7 square feet of effective area.

3.2.2.2 Bed Dimensions. The height of the pebble bed shall be 5 ft. minimum. Cross-sectional area (lateral dimensions) shall be determined, within the constraints identified, such that the static pressure drop across the pebble bed at nominal air flow rates through the bed shall be a minimum of 0.1 and a maximum of 0.6 inches of water column.

3.3 GRATING

The pebble bed shall rest on a metal grating which shall not allow properly sized pebbles to pass through, shall have strength to support the pebble bed weight, and shall minimize resistance to air flow.

3.4 PLENUM CHAMBERS

Plenum chambers shall be located at the top and bottom of the pebble bed and shall interface directly with the solar system main ductwork. They shall be designed to provide air flow vertically through the pebble bed in either direction. The plenums and inlets shall be designed to minimize air channeling through the pebble bed.

3.5 CONTAINER

The container, in combination with the plenum chambers, shall completely enclose the pebble bed and form an integral structure. Materials and fabrication techniques to be utilized are at the discretion of the builder/designer. House walls may form part or all of the container if structurally adequate.

3.6 PEBBLE BED ACCESS

Access must be provided to the pebble bed such that the pebbles can be inspected or replaced at any time. This access may be provided through the side walls of the container or through the upper plenum chamber.

3.7 INSULATION

Except for the interface with the main system ducts at the top and bottom plenum chambers, the energy storage subsystem shall be completely enclosed with insulation having a value of R11 or greater. This insulation can be mounted on inside or outside surfaces of the container and plenum chambers provided that thermal leakage paths to ambient conditions do not exist. At the interfaces with the solar system ductwork, the energy storage subsystem insulation must mate with the main duct insulation such that thermal leakage paths do not exist.

3.8 AIR AND WATER LEAKAGE

All elements of the energy storage subsystem shall be sealed to prevent air leakage from the air passages to ambient. The subsystem shall also be sealed to prevent ingress of ground water.

3.9 GROWTH OF FUNGI

Components and materials used in the energy storage subsystem shall not promote the growth of fungi, mold or mildew.

3.10 Pressure Drop

The static pressure drop across the Energy Storage Subsystem from inlet duct to exit duct shall be from .1 to .7 inches water column at nominal system flow-rates.

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IBM

FEDERAL SYSTEMS DIVISION
CODE IDENT 20234 = HUNTSVILLE, AL
CODE IDENT 52088 = MANASSAS, VA
CODE IDENT 03640 = OWEGO, NY

CONTRACT NO.

*CODE IDENT 20234

PL 7933610

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DATE 13[

ITLE

EN NO

SHEET 01

ENERGY STORAGE SUBSYSTEM

REFERENCE DESIGNATION	QUANTITY REQUIRED	UNIT MEAS	CODE IDENT	DRAWING OR DOCUMENT NO	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION
MS COMMON TO PART NUMBER 7933610						
	1	01			ESS-1	22 TONS WASHED RIVER STONES
	1	01			ESS-2	PEBBLE BED-REF INST. DWG
	1	01			ESS-3	GRATING-REF INST. DWG
	1	01			ESS-4	TYPE R-11 (FIBERGLASS OR OTHER)

D-7

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NIT OF MEASURE CODE
01 = PIECE EACH
11 = INCH
12 = FEET
18 = CUBIC FOOT
31 = OUNCE (AVDP)
35 = OUNCE (TROY)
59 = FLUID OUNCE
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L = DO NOT FILL N = VENDOR FURN R = REF X = DO NOT GENERATE Z = DUMMY CONNECT)

CHARACTER CODE (CH): A = WITH BILL OF MATL D = WITHOUT BILL OF MATL R = FACTORY REF

M NO. 952-6324-7

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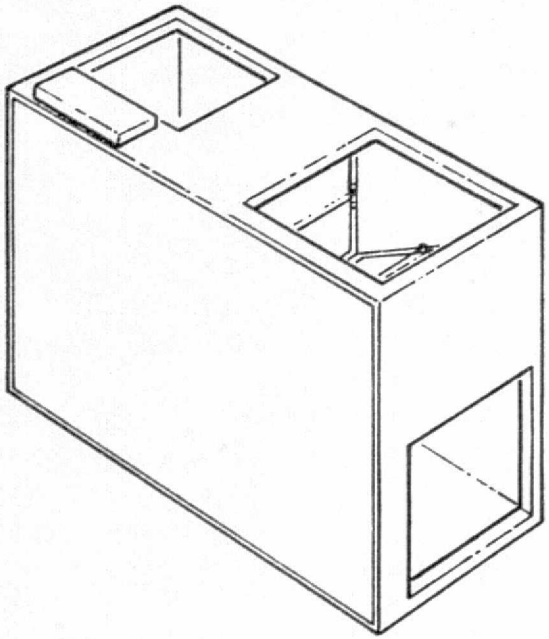
TECHNICAL APPROVAL				SYM	DATE	CHANGE NO
ELEC						
METAL						
PLASTIC						

7933611

DEVELOPMENT NO	Q/M



THE ENERGY TRANSPORT SUBSYSTEM CONSIST OF A PACKAGED SOLAR AIR HANDLER (IBM 7933623) AND NECESSARY DAMPERS, ACTUATORS, AND BACK DRAFT DAMPERS (INCLUDING IBM 7933625) TO ROUTE THE AIR FLOW FOR THE VARIOUS MODES OF OPERATION.

TJ-8

IBM MATERIAL	NO
IBM MATL ALTERNATE	NO
CASE DEPTH	
HARDNESS	
SURFACE TREATMENT	

7933611 | A

0 1 0 25,4

SCALE NONE

THIRD ANGLE PROJECTION

INCH

mm

MUST CONFORM TO ENG SPEC: 890350

TOLERANCES UNLESS OTHERWISE NOTED		INCH	mm
LINEAR ±			
ANGLES ±			
RADII UNLESS OTHERWISE NOTED			
EDGE/CORNER BREAKS	OUTSIDE MAX		
	INSIDE MAX		

IBM

NAME	ENERGY TRANSPOR
	SUBSYSTEM
DESIGNER	
DETAILER	11/22/
DWG CHK	
DSGN APPRO	
CLASSIFICATION	

620-7767-5 MRO# 780520797 MECHANICAL FORMAT ASTROCLOTH N650T

OGILVIE PRESS Buffalo, New York Printed in U.S.A.

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IBM

FEDERAL SYSTEMS DIVISION
CODE IDENT 20234 - HUNTSVILLE AL
CODE IDENT 52088 - MANASSAS, VA
CODE IDENT 03640 - OWEGO NY

CONTRACT NO.

CODE * IDENT 20234

PL 7933611

REVISION LTR + DATE 08DE

ITLE

EN NO.

SHEET 01 OF

ENERGY TRANSPORT SUBSYSTEM

REFERENCE DESIGNATION	QUANTITY REQUIRED	UNIT MEAS	CODE IDENT	DRAWING OR DOCUMENT NO	PART OR IDENTIFYING NO	NOMENCLATURE OR DESCRIPTION	SY
MS COMMON TO PART NUMBER 7933611							
	2	01			SHB-P-1217-HOR	COHRLASTIC DAMPER	
	1	01			SHB-P-1217-VERT	COHRLASTIC DAMPER	
	1	01			7933623	SOLAR AIR HANDLER	
	1	01			7933625	PARTIAL BACKDRAFT DAMPER	

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66 = CUBIC INCH

SYMBOL CODE (SY): V = VENDOR ITEM. SEE SPECIFICATION OR SOURCE CONTROL DRAWING

PLANNING CODE (PL): K = ALTERNATE ITEM P = BULK MATL (ALL OTHER PL CODES ARE FOR IBM REF ONLY: EG. G = GOVT FURN ITEM J = AS REQD L = DO NOT FILL N = VENDOR FURN R = REF X = DO NOT GENERATE Z = DUMMY CONNECT)

CHARACTER CODE (CH): A = WITH BILL OF MATL D = WITHOUT BILL OF MATL R = FACTORY REF

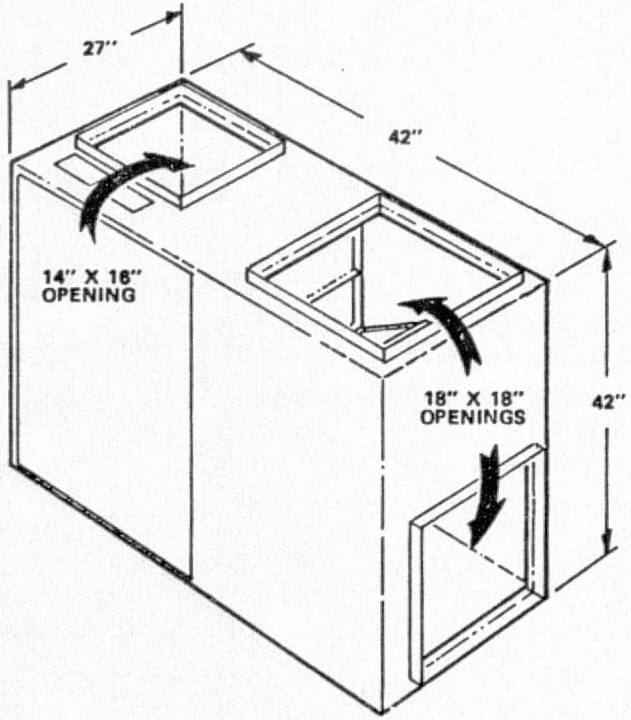
M NO. 952-6324-2

RELEASED FOR ASM	QTY
7933611	1

TECHNICAL APPROVAL				SYM	DATE	CHANGE NO
ELEC						
METAL						
PLASTIC						

7933623

DEVELOPMENT NO	Q/



D-10

THE AIR HANDLER CONTAINS THE BLOWER, BLOWER MOTOR AND NECESSARY DAMPERS AND ACTUATORS TO ROUTE THE AIR FLOW FOR THE VARIOUS MODES OF OPERATIONS.

AIR HANDLER

SOLAR CONTROL CORP.
MODEL SAM Series 20

THE MOTOR SIZE AND BLOWER SPEED ARE DETERMENED BY THE MAX. LOAD DEMANDS OF THE SYSTEM.(MOTORS ARE SPECIFIED IN TABLE "A".)
ALL 115 VAC WIRING IS TO BE (UL) LISTED.

TABLE "A"

H. P.	MANUFACTURE	STYLE NO.	FRAME TYPE
1/4	WESTINGHOUSE ELECTRIC CORP.	317P002	FH-SC56
1/3	WESTINGHOUSE ELECTRIC CORP.	317P003	FH-SP56
1/2	WESTINGHOUSE ELECTRIC CORP.	317P004	FH-56
3/4	WESTINGHOUSE ELECTRIC CORP.	312P629	FH-B56
1	WESTINGHOUSE ELECTRIC CORP.	311P297	FH-F56

DAMPER MOTORS WILL BE:

DAYTON No. 3M231 WITH MAGNETIC TYPE BRAKE REMOVED.
7 RPM, 1/100 H. P.
0.55 FLA, IMPEDANCE PROTECTED
115 VAC/60 CYCLES, CLOCK-WISE ROTATION (SHAFT END)

IBM MATERIAL	NO
IBM MATL ALTERNATE	NO
CASE DEPTH	
HARDNESS	
SURFACE TREATMENT	

7933623 A

0 1 0 25,4

SCALE NONE

THIRD ANGLE PROJECTION

INCH mm

MUST CONFORM TO ENG SPEC: 890350

TOLERANCES UNLESS OTHERWISE NOTED	INCH	mm
LINEAR ±		
ANGLES ±		
RADII UNLESS OTHERWISE NOTED		
EDGE/CORNER BREAKS OUTSIDE MAX		
EDGE/CORNER BREAKS INSIDE MAX		

IBM

NAME	SOLAR AIR HANDLEI	
DESIGNER		
DETAILER	JWP	12/2/76
DWG CHK		
DSGN APPRO		
CLASSIFICATION		

620-7767-5 MRO# 780520797 MECHANICAL FORMAT ASTROCLOTH N650T

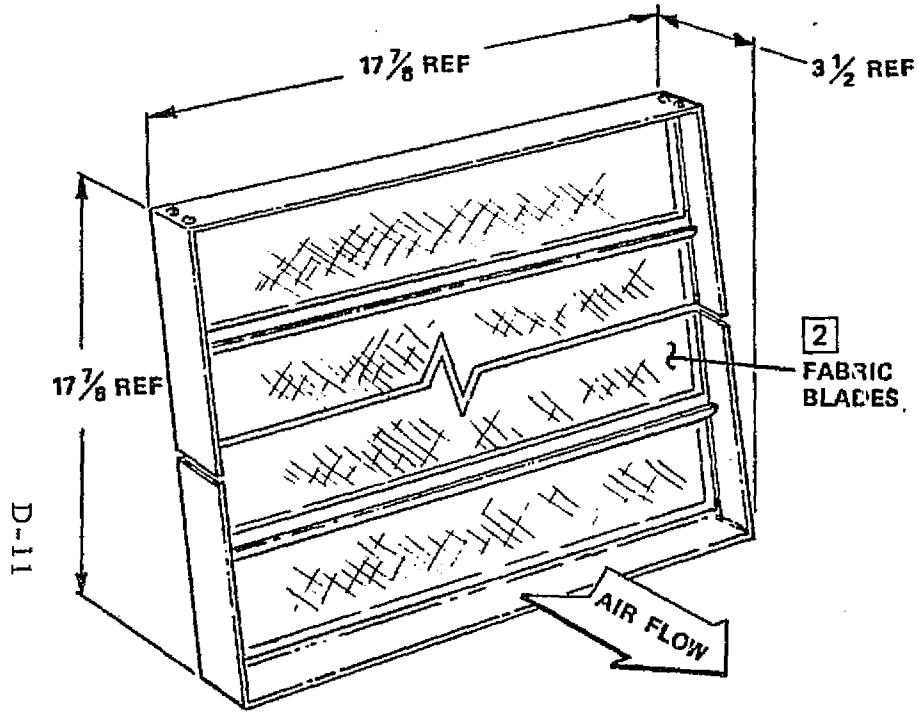
OGILVIE PRESS Buffalo, New York Printed in U.S.A.

RELEASED FOR ASM	QTY
7933611	1

TECHNICAL APPROVAL				SYM	DATE	CHANGE NO
ELEC						
METAL						
PLASTIC						

7933625

DEVELOPMENT NO | Q



NOTES:

1. ALTER AMERICAN WARMING AND VENTILATING INC. OF TOLEDO, OHIO PART NO. SHB-P-1217 FOR A 18" X 18" DUCT IN ACCORDANCE WITH THIS DRAWING. THIS PART CONTAINS FOUR 4" X 17" FABRIC BLADES AND ONE PARTIAL BLADE (NOT A FULL 4" HIGH)

[2] REMOVE ONE (FULL) CENTER BLADE BY CUTTING ALONG THE HINGED EDGE. IF CENTER BLADE IS NOT A FULL BLADE REMOVE THE ADJACENT FULL BLADE (ONE ONLY)

- COMMERCIAL ITEM

IBM MATERIAL	NO
IBM MATL. ALTERNATE	NO
CASE DEPTH	
HARDNESS	
SURFACE TREATMENT	

7933625 | A

0 1 0 25,4

SCALE NONE

THIRD ANGLE PROJECTION

INCH mm

MUST CONFORM TO ENG SPEC. 890350

TOLERANCES UNLESS OTHERWISE NOTED		INCH	mm
LINEAR ±			
ANGLES ±			
RADII UNLESS OTHERWISE NOTED			
EDGE/CORNER BREAKS	OUTSIDE MAX		
	INSIDE MAX		

IBM

NAME	DAMPER, PARTIAL BACK DRAFT	
DESIGNER		
DETAILER	DWP	12/1
DWG CHK	D Sinton	12/2
DSGN APPRO	Kreske	12-1
CLASSIFICATION		

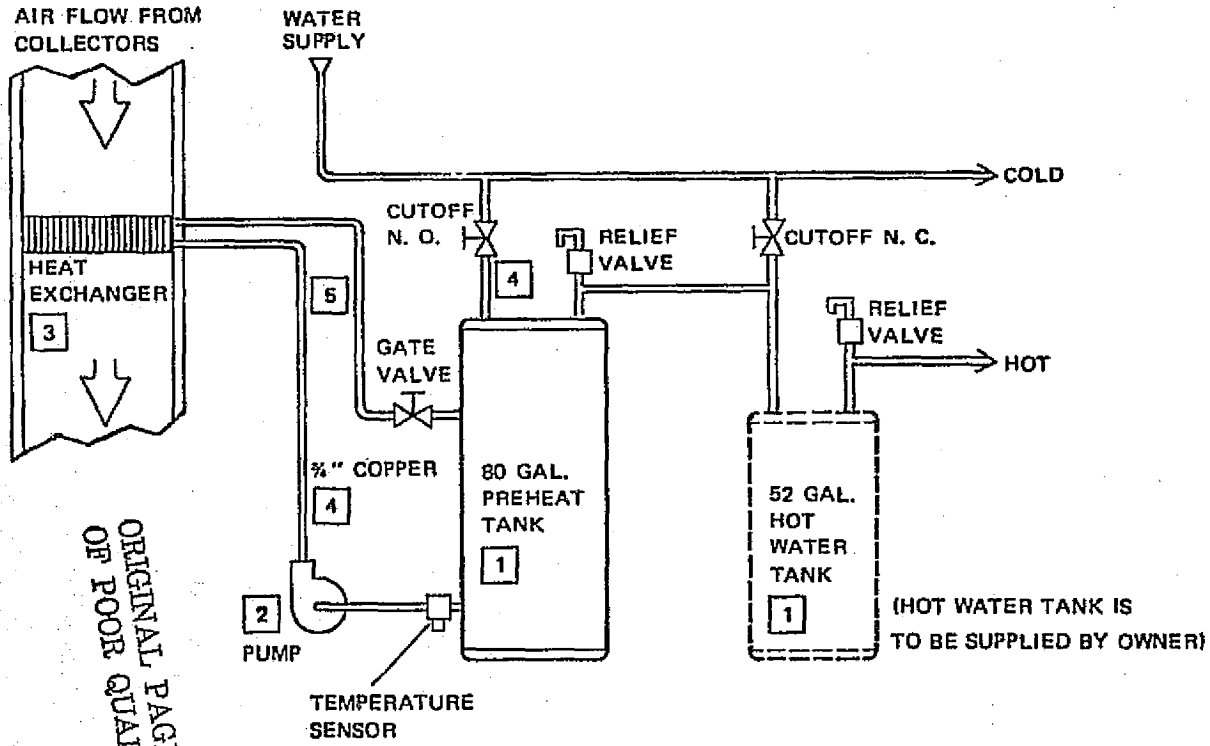
620-7767-5 MRO# 780520797 MECHANICAL FORMAT ASTROCLOTH N650T OGILVIE PRESS Buffalo, New York Printed in U.S.A.

RELEASED FOR ASM	QTY
7933608	1

TECHNICAL APPROVAL				SYM	DATE	CHANGE NO
ELEC						
METAL						
PLASTIC						

7933612

DEVELOPMENT NO



NOTES:

1. ALL TANK CONNECTIONS ARE ¾" MPT
2. PUMP CONNECTIONS ARE 1.0" IPT, ELECTRICAL SERVICE FROM INTERFACE CONTROLLER BOX
3. HEAT EXCHANGER CONNECTIONS ARE 1.0" MPT
4. ALL PIPING IS ¾" COPPER TUBING OR EQUIVALENT, INSULATED WITH A MIN. R VALUE OF 5.0 ON HOT WATER LINES
5. PIPING IN CIRCULATION LOOP CAN NOT EXCEED 50' OF ¾" COPPER TUBING OR EQUIVALENT
6. FLANGE ISOLATION VALVES ARE USED ON INPUT & OUTPUT FROM PUMP

D-12

ORIGINAL PAGE IS OF POOR QUALITY

IBM MATERIAL	NO
IBM MATL ALTERNATE	NO
CASE DEPTH	
HARDNESS	
SURFACE TREATMENT	

7933612 A

0 25.4

SCALE NONE

THIRD ANGLE PROJECTION

INCH mm

MUST CONFORM TO ENG SPEC: 890350

TOLERANCES UNLESS OTHERWISE NOTED		INCH	mm
LINEAR ±			
ANGLES ±			
RADII UNLESS OTHERWISE NOTED			
EDGE/CORNER BREAKS	OUTSIDE MAX		
	INSIDE MAX		

IBM

NAME	HOT WATER SUBSYSTEM	
DESIGNER	M. Stickel	11-1
DETAILER	J. Perry	11-11
DWG CHK		11-11
DSGN APPRO		11-
CLASSIFICATION		

PARTS LIST

IBM

FEDERAL SYSTEMS DIVISION
CODE IDENT 20234=HUNTSVILLE, AL
CODE IDENT 52088=MANASSAS, VA
CODE IDENT 03640=OWEGO, NY

CONTRACT NO.

CODE *IDENT: 20234

PL 7933612

REVISION LTR A DATE 03APR78

LIST TITLE: HOT WATER SUBSYSTEM

EN NO.: EN6633IS

SHEET: 01 OF 01

ITEM NO.	REFERENCE DESIGNATION	QUANTITY REQUIRED	UNIT MEAS	CODE IDENT	DRAWING OR DOCUMENT NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	SY	PL	CH
ITEMS COMMON TO PART NUMBER7933612										
		1	99			HWS1	3/4 " COPPER TUBING & FITTINGS		N	D
		2	01			HWS2	BRONZE CUTOFF VALVE		N	D
		1	01			SW2-18-18-8	HALSTEAD MITCHELL HEAT EXCHANGER			D
		1	01			T-113	NIBCO BRONZE GATE VALVE 3/4"			D
		1	01			UC05225	JACKSON STORAGE UNIT			D
		1	01			UP-25-42-SF	GRUNDFOS PUMP, ISOLATION VALVES			D
		1	01			S2GAL	HOT WATER HEATER		N	D

UNIT OF MEASURE CODE
01 = PIECE EACH
11 = INCH
12 = FEET
16 = CUBIC FOOT
31 = OUNCE (AVDP)
35 = OUNCE (TROY)
59 = FLUID OUNCE
66 = CUBIC INCH

SYMBOL CODE (SY): V = VENDOR ITEM, SEE SPECIFICATION OR SOURCE CONTROL DRAWING

PLANNING CODE (PL): K = ALTERNATE ITEM P = BULK MATL (ALL OTHER PL CODES ARE FOR IBM REF ONLY; EG, G = GOVT FURN ITEM J = AS REQD L = DO NOT FILL N = VENDOR FURN R = REF X = DO NOT GENERATE Z = DUMMY CONNECT)

CHARACTER CODE (CH): A = WITH BILL OF MATL D = WITHOUT BILL OF MATL R = FACTORY REF

IBM FORM NO. 952-6324-2

RELEASED FOR ASM	QTY	TECHNICAL APPROVAL				SYM	DATE	CHANGE NO		SYM	DATE	CHANGE NO	7933613
7933608	1	ELEC				–	JAN11.77	663373 C.					
		METAL				A	[illegible]	663376 C.A					DEVELOPMENT NC
		PLASTIC											

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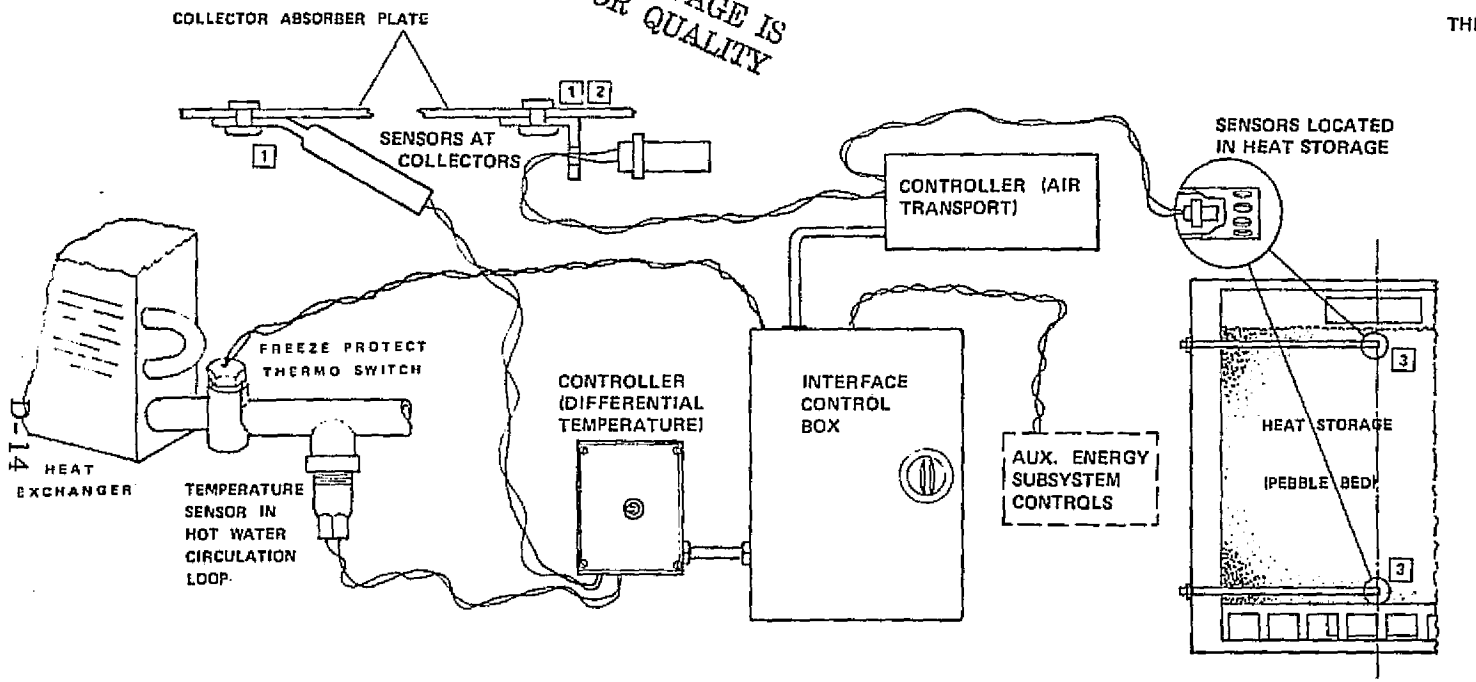
OF POOR QUALITY



THE CONTROL SUBSYSTEM IS COMPRISED OF THREE FUNCTIONAL UNITS WHICH ARE INTERCONNECTED WITH EACH OTHER AND THE AUX. ENERGY SUBSYS

THE FUNCTIONAL UNITS ARE:

CONTROLLER (AIR TRANSPORT)	SOLAR CONTROL CORP. ZIA MODEL 75-176
CONTROLLER (DIFFERENTIAL TEMPERATURE)	RHO SIGMA MODEL 106
INTERFACE CONTROL BOX	IBM 7933619

NOTES:

1. COLLECTOR SENSORS MOUNTED FOR GOOD THERMAL CONTACT AND MAXIMUM EXPOSU TO AIR FLOW AT EXIT DUCT
2. SENSOR MOUNTING BRACKET NOT TO EXCE 1/16" THICK X 1" LEGS
3. TYPICAL ACCESS TO CENTER-LINE OF STOR IS AT A LEVEL 6" FROM TOP OF ROCK A 6" FROM BOTTOM WITH CONDUIT OF ½" I. MINIMUM

IBM MATERIAL NO		0 / 0 25.4	MUST CONFORM TO ENG SPEC: 890350			IBM
IBM MATL ALTERNATE NO		SCALE NONE	TOLERANCES UNLESS OTHERWISE NOTED	INCH	m m	NAME CONTROL SUBSYSTEM
CASE DEPTH			LINEAR ±			DESIGNER M Scott 11/22/
HARDNESS			ANGLES ±			DETAILER [illegible] 11/20
SURFACE TREATMENT		THIRD ANGLE PROJECTION	RADII UNLESS OTHERWISE NOTED			DWG CHK [illegible] 11/23/
7933613	B	INCH m m	EDGE/CORNER BREAKS OUTSIDE MAX			DSGN APPRO [illegible]
			INSIDE MAX			CLASSIFICATION

820-7368-3 MRO# 700520007 MECHANICAL FORMAT

PARTS LIST

IBM

FEDERAL SYSTEMS DIVISION
CODE IDENT 20234=HUNTSVILLE, AL
CODE IDENT 52088=MANASSAS, VA
CODE IDENT 03640=OWEGO, NY

CONTRACT NO.

CODE *IDENT: 20234 | PL 7933613 | REVISION LTR A | DATE 03APR78

LIST TITLE: CONTROL SUBSYSTEM

EN NO.: EN65352CA

SHEET: 01 OF 01

ITEM NO.	REFERENCE DESIGNATION	QUANTITY REQUIRED	UNIT MEAS	CODE IDENT	DRAWING OR DOCUMENT NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	SY	PL	CH
ITEMS COMMON TO PART NUMBER 7933613										
1		1	01			7933624	SOLAR AIR CONTROLLER			D
2		1	01			7933619	SYSTEM1-INTERFACE CONTROL BOX			A
3		1	01			DELTA-T-MOD-106	CONTROLLER (RHO-SIGMA)			D
4		1	01			ELMWOOD-3000	THERMOSWITCH			D

UNIT OF MEASURE CODE
01 = PIECE EACH
11 = INCH
12 = FEET
18 = CUBIC FOOT
31 = OUNCE (AVDP)
35 = OUNCE (TROY)
59 = FLUID OUNCE
66 = CUBIC INCH

SYMBOL CODE (SY): V = VENDOR ITEM, SEE SPECIFICATION OR SOURCE CONTROL DRAWING

PLANNING CODE (PL): K = ALTERNATE ITEM P = BULK MATL (ALL OTHER PL CODES ARE FOR IBM REF ONLY; EG, G = GOVT FURN ITEM J = AS REQD L = DO NOT FILL N = VENDOR FURN R = REF X = DO NOT GENERATE Z = DUMMY CONNECT)

CHARACTER CODE (CH): A = WITH BILL OF MATL D = WITHOUT BILL OF MATL R = FACTORY REF

IBM FORM NO. 952-6324-2

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RELEASED FOR ASM	QTY
7933608	1

TECHNICAL APPROVAL			SYM	DATE	CHANGE NO	SYM	DATE	CHANGE NO
ELEC								
METAL								
PLASTIC								

7933619

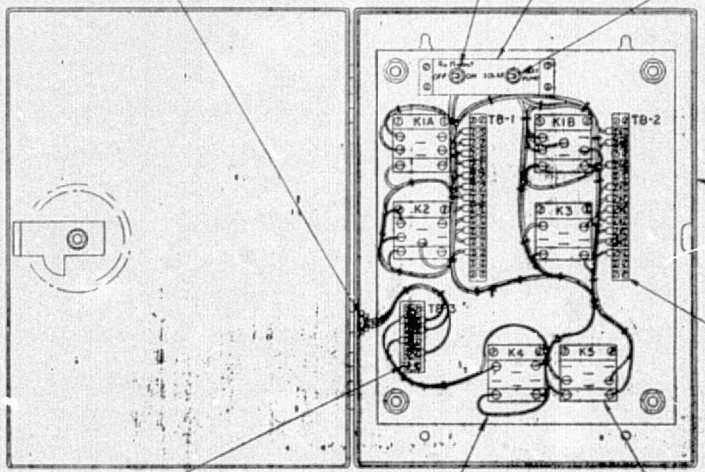
DEVELOPMENT NO

S2 SWITCH MST-115D
ALCO, MARYLAND HEIGHTS
MO. 63043

7933621 BRACKET

BOX CONNECTOR, RACO-2863
SOUTH NORWALK, CONN. 06854

S1 4PDT SWITCH MST415N
ALCO, MARYLAND HEIGHTS, MO.
63043



PANEL ENCLOSURE
HOFFMAN NEMA TYPE 1, A-16N12A
ANOKA, MINN.

TB-1, TB-2
13-540 TERMINAL BLOCK
TRW CINCH, ELK GROVE, ILL. 60007
(4X) SCREW, 6-32 X .250

TB-3
4-540 TERMINAL BLOCK,
365-41-04-020 SHIELD, TRW CINCH,
ELK GROVE, ILL. 60007
(3X) SCREW, 6-32 X .250
210884 STUD
210883 STUD

WIRE (ALL) 18GA. PVC
COLOR CODED
BELDEN CORP., GENEVA, ILL.

K1-THRU-K5
90-340 RELAY, ESSEX, LOGANSPORT, IND.
(12X) SCREW, 8-32 X .250

7933619-D

IBM MATERIAL	NO
IBM MATL. ALTERNATE	NO
CASE DEPTH	
HARDNESS	
SURFACE TREATMENT	

SCALE 1/2

THIRD ANGLE PROJECTION

INCH / mm

MUST CONFORM TO ENG SPEC. 690350

TOLERANCES UNLESS OTHERWISE NOTED	INCH	mm
LINEAR ±		
ANGLES ±		
RADII UNLESS OTHERWISE NOTED		
EDGE/CORNER BREAKS	OUTSIDE MAX	
	INSIDE MAX	

IBM

NAME	INTERFACE CONTROL BD.
DESIGNER	
DETAILED	
SYM CHK	
DSGN APPRO	
CLASSIFICATION	

7933619

D-16

PARTS LIST | IBM | FEDERAL SYSTEMS DIVISION
CODE IDENT 20234 – HUNTSVILLE, AL
CODE IDENT 52098 – MANASSAS, VA
CODE IDENT 03640 – OWEGO, NY

CONTRACT NO. SIMS | *CODE IDENT 20234 | PL 7933619 | REVISION LTR + DATE 30DEC76

LIST TITLE: SYSTEM1-INTERFACE CONTROL BOX | EN NO. | SHEET 01 OF 01

ITEM NO.	REFERENCE DESIGNATION	QUANTITY REQUIRED	UNIT MEAS	CODE IDENT	DRAWING OR DOCUMENT NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	SY	PL	CH
ITEMS COMMON TO PART NUMBER 7933619										
1		1	01	00843		A-16N12A	NEMA PANEL ENCLOSURE			D
2		6	01			KIT90-340	TYPE 90 DPDT RELAY			D
3		1	01			MST415N	4PDT SWITCH			D
4		1	01	03640	6080555	MST-115D	SWITCH TOGGLE			D
5		2	01	71785		13-540	540 SERIES TERM BLOCK			D
6		1	01	71785		4-540	540 SERIES TERM BLOCK			D
7		1	01	71785		365-41-04-020	SAFETY SHIELD			D
8		1	01			210884	STUD			D
9		1	01	88360		210883	STUD			D
10		16	01	88360		10170	SCREW 6-32X.250H			D
11		1	01			7933621	BRACKET			D
12		12	01			MS16212-41	SCREW,6-32			D
13		1	01			RACO-2863	BOX CONNECTORS			D
14		50	01			DV18-250-C	FEMALE QUICK DISCONNECT TERM.			D
15		50	01			PN16-6R-C	WIRE TERMINAL INSULATED			D
16		50	01			PLTIM-CP	PLASTIC WIRE TIE			D
17		12	12			8816-5	18AWG WIRE-PVC-GRN		P	D
18		12	12			8816-3	18AWG WIRE-PVC-ORANGE		P	D
19		12	12			8816-9	18 AWG WIRE-PVC-WHITE		P	D
20		12	12			8816-2	18 AWG WIRE-PVC-RED		P	D
21		12	12			8816-6	18 AWG WIRE-PVC-BLUE		P	D
22		12	12			8d16-4	18 AWG WIRE-PVC-YELLOW		P	D
23		12	12			8816-10	18 AWG WIRE-PVC-BLACK		P	D
24		1	01			7933622	SCHEMATIC, INTERFACE CONTROL			D

UNIT OF MEASURE CODE
01 – PIECE EACH
11 – INCH
12 – FEET
18 – CUBIC FOOT
31 – OUNCE (AVDP)
35 – OUNCE (TROY)
59 – FLUID OUNCE
65 – CUBIC INCH

SYMBOL CODE (SY): V – VENDOR ITEM. SEE SPECIFICATION OR SOURCE CONTROL DRAWING

PLANNING CODE (PL): K – ALTERNATE ITEM P – BULK MATL (ALL OTHER PL CODES ARE FOR IBM REF ONLY: EG. G – GOVT FURN ITEM J – AS REQD L – DO NOT FILL N – VENDOR FURN R – REF X – DO NOT GENERATE Z – DUMMY CONNECT)

CHARACTER CODE (CH): A – WITH BILL OF MATL D – WITHOUT BILL OF MATL R – FACTORY REF

IBM FORM NO. 552 6324 2

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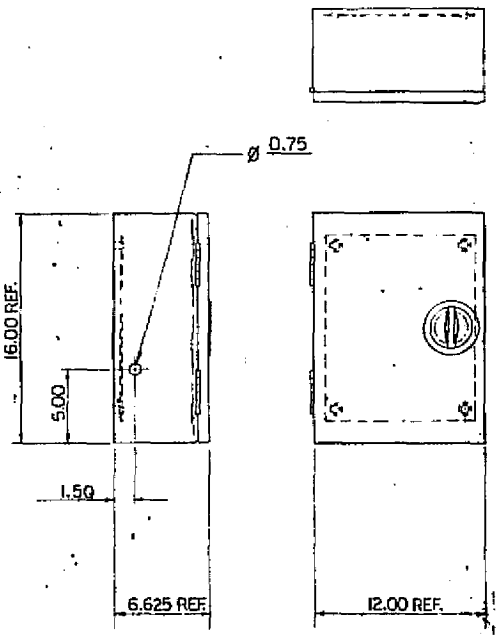
RELEASED FOR ASN	QTY
7933619	1

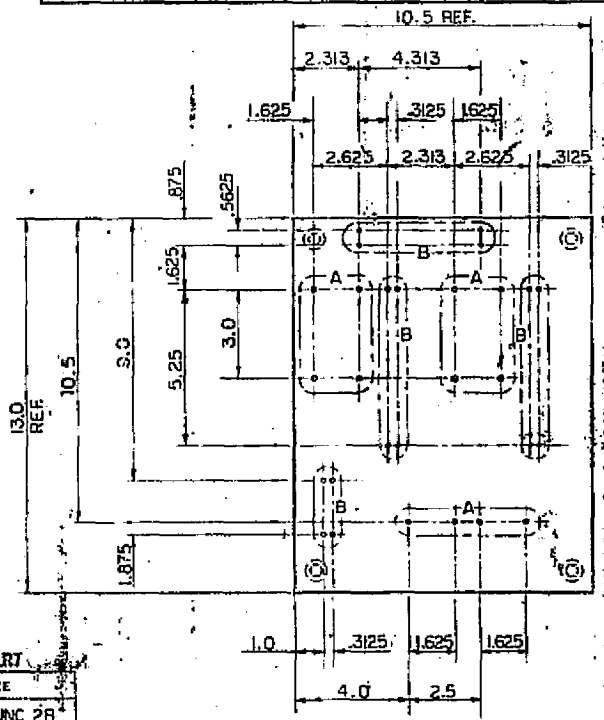
TECHNICAL APPROVAL	SYM	DATE	CHANGE NO	SYM	DATE	CHANGE NO
ELEC						
METAL						
PLASTIC						

7933620

DEVELOPMENT NO. SYM



CONTROLLER ENCLOSURE
SCALE 1/4



HOLE CHART

HOLE	NO	SIZE
A	12	8-32 UNC 2B
B	16	6-32 UNC 2B

INTERNAL PANEL
SCALE 1/2

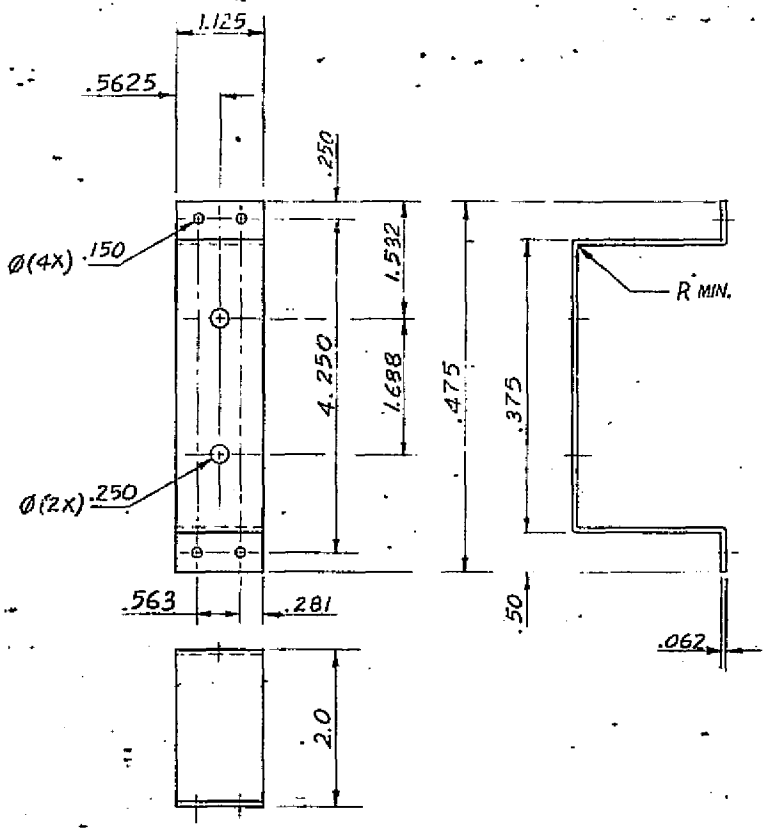
7933620-D

IBM MATERIAL	NO		MUST CONFORM TO ENG SPEC 690350		IBM
IBM MATL ALTERNATE	NO		TOLERANCES UNLESS OTHERWISE NOTED	INCH / mm	NAME INTERFACE CONTROL BOX
CASE DEPTH		SCALE AS NOTED	LINEAR ±	.005/.002	DESIGNER 27 OCT 78
HARDNESS		THIRD ANGLE PROJECTION	ANGLES ±		DETAILER 15 NOV 78
SURFACE TREATMENT	PAINT EXTERIOR OF BOX BLUE, KRYLON 1901	INCH / mm	RADII UNLESS OTHERWISE NOTED		DWG CHK
			EDGE/CORNER OUTSIDE MAX		DESIGN APPD
			BREAKS INSIDE MAX		CLASSIFICATION

D

7933620

RELEASED FOR ASM	QTY	TECHNICAL APPROVAL				SYM	DATE	CHANGE NO		SYM	DATE	CHANGE NO	7933621
7933619 -	1	ELEC											DEVELOPMENT NO / Q/M
		METAL											
		PLASTIC											



7933621-C

IBM MATERIAL NO 6061 – T6 ALUMINUM	0 1 2 / 0 25.4 50.8	MUST CONFORM TO ENG SPEC: 880350			IBM	
IBM MATL ALTERNATE NO	SCALE 1/1	TOLERANCES UNLESS OTHERWISE NOTED	INCH	m m	NAME	BRACKET, INTERFACE CONTROL BOX
CASE DEPTH		LINEAR ±	±.005/-.002		DESIGNER	27 Feb 76
HARDNESS	THIRD ANGLE PROJECTION	ANGLES ±			DETAILER	28 Dec 76
SURFACE TREATMENT 218 CHROMATE	INCH / m m	RADII UNLESS OTHERWISE NOTED			DWG CHK	
7933621 C		EDGE/CORNER BREAKS MIN. OUTSIDE MAX / INSIDE MAX			DSGN APPRO	28 Dec 76
					CLASSIFICATION	

D-19

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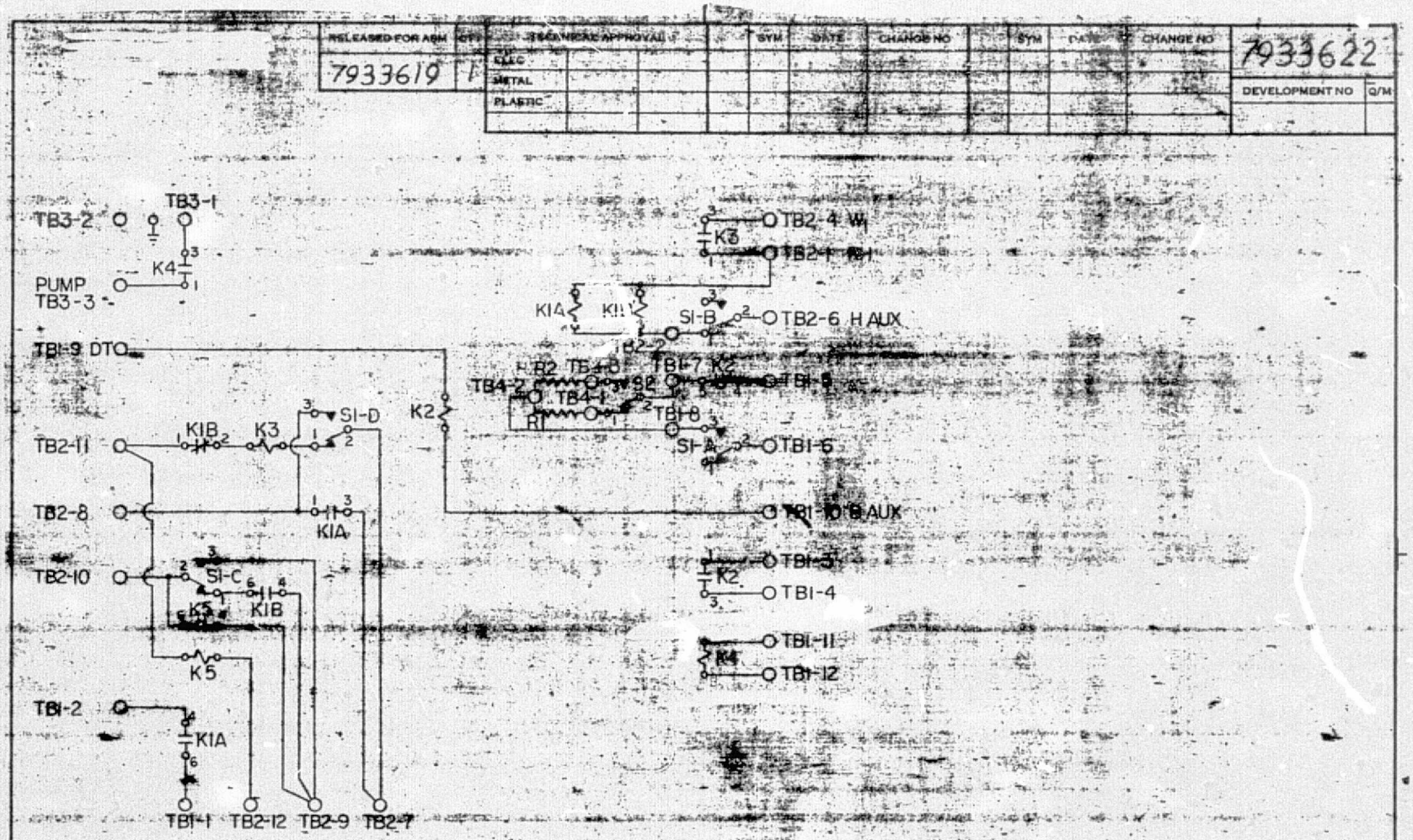

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RELEASED FOR ASM	QTY
7933613	1

TECHNICAL APPROVAL				SYM	DATE	CHANGE NO
ELEC						
METAL						
PLASTIC						

793362

DEVELOPMENT NO

THE SOLAR AIR CONTROLLER IS A PACKAGED ELECTRICAL CONTROL SYSTEM.

SOLAR AIR CONTROLLER — ZIA ASSOCIATES, INC. MODEL 75-176 (FOUR MODE CONTROLLER)

THE SOLAR AIR CONTROLLER IS TO HAVE:

1. (UL) LISTED WIRE ABOVE 70 VOLTS.
2. (UL) LISTED 24V RELAYS. (HONEYWELL R8225D1003 & R8225A1017)
3. CLASS II TRANSFORMER. (HONEYWELL AT74B1004)

STANDARD FEATURES FROM MANUFACTURE ARE:

1. DIFFERENTIAL OFFSET PROGRAMMABLE 10^{o} - 60^{o} F.
2. HYSTERESIS PROGRAMMABLE 3^{o} - 20^{o} F.
3. PROGRAMMABLE DELIVERY TEMPERATURE SET 90^{o} - 120^{o} F.
4. FOR 115 VAC OPERATION.

D-21

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IBM MATERIAL	NO
IBM MATL ALTERNATE	NO
CASE DEPTH	
HARDNESS	
SURFACE TREATMENT	

7933624 | A

0 1 0 25,4

SCALE ~

THIRD ANGLE PROJECTION

INCH mm

MUST CONFORM TO ENG SPEC: 890350

		INCH	mm
TOLERANCES UNLESS OTHERWISE NOTED			
LINEAR ±			
ANGLES ±			
RADII UNLESS OTHERWISE NOTED			
EDGE/CORNER BREAKS	OUTSIDE MAX		
	INSIDE MAX		

IBM

NAME	SOLAR AIR CONTROLL	
DESIGNER	T. Easton	12
DETAILER	DW Terry	12
DWG CHK		
DSGN APPRO		
CLASSIFICATION		

REVISIONS					
CHK	ENGRG NOTICE	LTR	DESCRIPTION	DATE	APPROVED
	K42-009	--	Release	11/22/76	

DWG NO. 7933614

The Auxiliary Energy Subsystem provides the necessary energy to supplement the solar system. It is designed to provide the entire heating load in the event solar energy is not available. In addition, the system will provide cooling for summer time operation.

The subsystem consists of a air-to-air split-system heat pump and separate resistance heaters.

The heat pump is sized for the building cooling load. Heating capacity of the heat pump is augumented by the resistance heaters to meet the building heating load at local design temperatures. The resistance heaters are located in the transport system such that the solar heating may also be augumented.

The heat pump and resistance heaters shall be furnished by the building owner.

CONTR NO.	INTERNATIONAL BUSINESS MACHINES CORP. FEDERAL SYSTEMS DIVISION HUNTSVILLE, ALA. 35807
PREPARATION 11-23-76	TITLE
DSGN CHK 11-23-76	AUXILIARY ENERGY SUBSYSTEM
DWG CHK	
DSGN APPROVAL 11-22-76	SIZE A / CODE IDENT NO. / DWG NO. 7933614
	SCALE / WT / SHEET

955-1685-0

REVISIONS					
CHK	LNGRG NOTICE	LTR	DESCRIPTION	DATE	APPROVED

DWG NO. 7933615

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CONTR NO.	INTERNATIONAL BUSINESS MACHINES CORP. FEDERAL SYSTEMS DIVISION HUNTSVILLE, ALA. 35807
PREPARATION	
DSGN CHK	TITLE: Integration Subsystem Specification
DWG CHK	
DSGN APPROVAL	SIZE: A | CODE IDENT NO. | DWG NO.: 7933615
	SCALE | WT | SHEET

955-1685-0

1.0 SCOPE

1.1 This specification describes the design, fabrication and installation requirements for the Integration Subsystem of Solar Heating and Hot Water System 1.

2.0 APPLICABLE DOCUMENTS

The following documents form a part of this specification to the extent that they apply to the items of hardware noted herein:

- o Interim Perfor·ance Criteria Commercial Solar Heating/Cooling Subsystems and Facilities (hereafter referred to as the IPC)
- o Intermediate Minimum Property Standards for Solar Heating and Domestic Hot Water Systems
- o Local Building, Plumbing, Mechanical, Electrical and Fire Protection Codes
- o Installation Plans and Specifications

3.0 REQUIREMENTS

3.1 General.

The Integration Subsystem consists of the necessary hardware to interconnect the various subsystem components to provide a solar heating and hot water system.

3.1.1 Fire safety. All materials used to install and insulate the collector subsystem shall meet the fire hazard requirements of the IPC. Materials shall have a flame-spread rating not over 25 and a smoke developed rating not higher than 50 per ASTM E84, UL 733. Duct tape shall not be more combustible than approved flame-proofed fabric.

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3.1.2 Corrosion. Materials used to install and insulate the collector subsystem shall be selected so that their performance will not be affected by corrosion over the 20-year life of the system.

3.1.4 Thermal environment. Materials used to install and insulate the collector subsystem shall be capable of withstanding temperature from -10°F to 250°F without deterioration.

3.2 Interconnecting Ducts

Within the CFM, velocity and static pressure parameters called for in the System Design Specification, the interconnecting ducts may vary in size as dictated by the availability of space within the building and the size of the connections to the various subsystems serviced by this hardware. However, the installation design shall provide as short a run as practical to minimize friction losses. All duct joints and connections shall be designed to minimize air leakage and shall provide necessary brackets, angles and supporting hardware to minimize stresses on subsystem components.

3.3 Duct Sealing Material

All duct joints and interface with subsystem components shall be sealed with duct tape or suitable sealant to eliminate air leakage.

3.4 Dampers

3.4.1 Back-draft dampers. Four automatic back-draft dampers shall be installed in the duct work to provide for flow control and regulation. Location of these dampers will be in accordance with the system schematic P/N 7933608.

3.4.2 Shut-off dampers. Four manually operated dampers shall be installed within the interconnecting duct work to provide for collector and attic ventilation and isolation of the Pebble Bed Storage unit during summer operation. The attic and outside ventilating units shall have insect screens attached to the damper unit. The damper unit shall be selected on the basis of providing minimum air leakage when closed and pressure drop when open.

3.5 Heat Exchanger

An air-to-water heat exchanger shall be installed in the duct work to provide pre-heat of domestic hot water. Location will be in accordance with system schematic P/N 7933608.

3.6 Duct Insulation

All interconnecting ducts shall be insulated with material having an R value of not less than 16.5.

3.7 Duct Hangers

All interconnecting ducts shall be suitably supported to minimize stresses within the ducts and at duct joints to prevent separation and leakage.

3.8 Filters

An UL approved all metal heavy duty wire mesh commercial filter shall be installed in the inlet duct from the attic ventilation intake. The size and mounting detail shall be incorporated in the system installation drawings.

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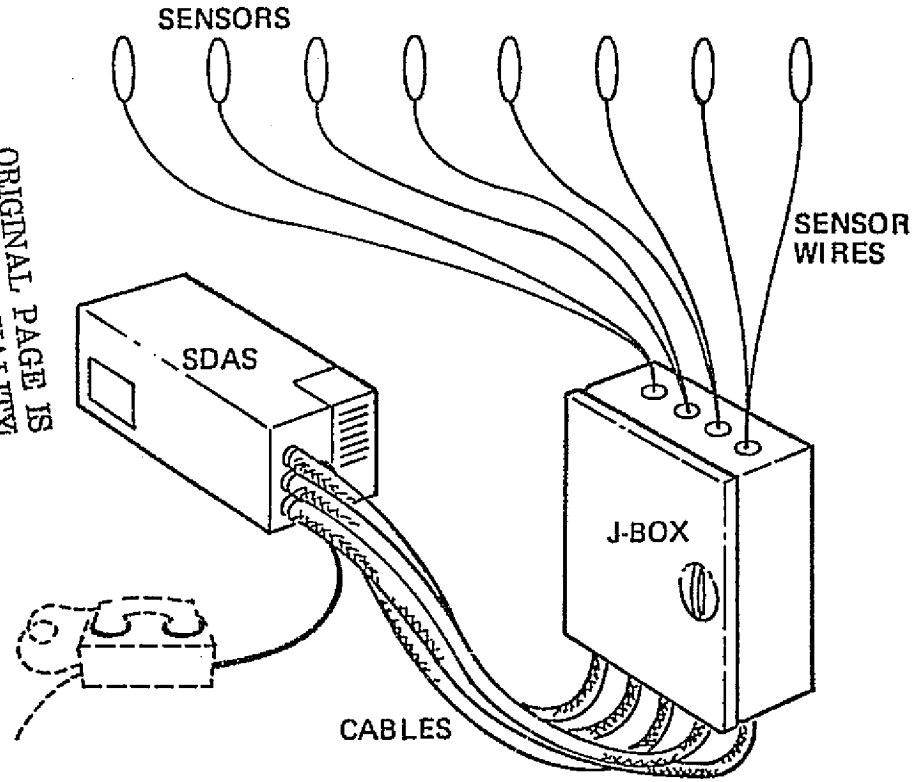
RELEASED FOR ASM	QTY
7933608	1

TECHNICAL APPROVAL				SYM	DATE	CHANGE NO
ELEC						
METAL						
PLASTIC						

7933616

DEVELOPMENT NO



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G-1

THE DATA COLLECTION SUBSYSTEM CONSISTS OF FIVE ITEMS:

SDAS	P/N 7932922
JUNCTION BOX (J-BOX)	P/N 7933585
CABLES (J-BOX TO SDAS)	P/N 7933578 P/N 7933579-2 P/N 7933583 P/N 7933579-1
SENSORS (AS LISTED ON)	PL 7933616
SENSOR WIRE LIST	W/L 7933616

SENSORS WILL BE DELIVERED AT SITE AS REQUIRED DURING INSTALLATION.

IBM MATERIAL	NO
IBM MATL ALTERNATE	NO
CASE DEPTH	
HARDNESS	
SURFACE TREATMENT	

7933616 A

0 1 0 25.4

SCALE NONE

THIRD ANGLE PROJECTION

INCH mm

MUST CONFORM TO ENG SPEC: 890350

		INCH	mm
TOLERANCES UNLESS OTHERWISE NOTED			
LINEAR ±			
ANGLES ±			
RADII UNLESS OTHERWISE NOTED			
EDGE/CORNER BREAKS	OUTSIDE MAX		
	INSIDE MAX		

IBM

NAME	DATA COLLECTI SUBSYSTEM	
DESIGNER		
DETAILER	DaP	11/2
DWG CHK		
DSGN APPRO		
CLASSIFICATION		

PARTS LIST

IBM

FEDERAL SYSTEMS DIVISION
CODE IDENT 20234 - HUNTSVILLE AL
CODE IDENT 52088 - MANASSAS, VA
CODE IDENT 03640 - OWEGO, NY

CONTRACT NO.

CODE *IDENT 20234

PL 7933616

REVISION LTR + DATE 15DE

TITLE

SDC SUBSYSTEM-IBM SYSTEM 1

EN NO

SHEET 01 OF

IM NO.	REFERENCE DESIGNATION	QUANTITY REQUIRED	UNIT MEAS	CODE IDENT	DRAWING OR DOCUMENT NO.	PART OR IDENTIFYING NO.	NOMENCLATURE OR DESCRIPTION	SY
	ITEMS COMMON TO PART NUMBER 7933616							
		AR				DC340	THERMAL TRANSFER GREASE	
		AR				DC96-080	ADHESIVE	
		20	01			F102-4	WEATHERHEAD	
		17	01			F132	FITTING	
		5	01			F203U28	THERMOWELL	
		1	01			IS4	RADIATION SHIELD	
		2	01			MKV-3/4-J07	FLOWMETER	
		1	01			PC5-1F	WATTMETER	
		1	01			PC5-19F	WATTMETER	
		1	01			PC5-2F	WATTMETER	
		1	01			PC5-28F	WATTMETER	
		1	01			PC5-29F	WATTMETER	
		1	01			PC5-32F	WATTMETER	
		1	01			PYRANOMETER	PYRANOMETER, PRECISION	
		2	01			S53P55Z36	SINGLE ELEMENT PROBE	
		3	01			S53P700Z36	SINGLE ELEMENT PROBE	
		7	01			S53P85Z36	SINGLE ELEMENT PROBE	
		3	01			S57P55Z36	DUAL ELEMENT PROBE	
		5	01			S57P85Z36	DUAL ELEMENT PROBE	
		2	01			430-2	FLOW PROBE	
		1	01			7932922	SDCS UNIT ASSY 47 CH	
		1	01			7933585	J-BOX (32 CHAN) SDAS INTERFACE	

C-2

UNIT OF MEASURE CODE
01 = PIECE EACH
11 = INCH
12 = FEET
18 = CUBIC FOOT
31 = OUNCE (AVDP)
35 = OUNCE (TROY)
59 = FLUID OUNCE
66 = CUBIC INCH

SYMBOL CODE (SY): V = VENDOR ITEM. SEE SPECIFICATION OR SOURCE CONTROL DRAWING

PLANNING CODE (PL): K = ALTERNATE ITEM P = BULK MATL (ALL OTHER PL CODES ARE FOR IBM REF ONLY: EG. G = GOVT FURN ITEM J = AS REQD L = DO NOT FILL N = VENDOR FURN R = REF X = DO NOT GENERATE Z = DUMMY CONNECT)

CHARACTER CODE (CH): A = WITH BILL OF MATL D = WITHOUT BILL OF MATL R = FACTORY REF

FORM NO 952-6374 2

IBM FORM NO. 952 5260-2

DWG NO. IP 7933616

H

REVISIONS

CHK	ENGRG NOTICE	LTR	DESCRIPTION	DATE	APPROVED
R	66348NW	H	PEPLACE PAGE 1-SEE EN. REV PAGE 7-COL 7. REV PAGE 8-COL 9. REV PAGE 13-COL 7 DEFINITION. REV PAGE 14-COL 9 DEFINITION. REV PAGE 17-REV SCHEMATIC. REV PAGE 22-CHANGE TD & T QUANTITIES. REV PAGE 23 to 28-CHANGE TDs to Ts, & ADD T COEFFICIENTS. CHANGE T RANGES AND MICRO-BOARDS. CHANGE LIQUID FLOW RANGES & ADD PAGE 29.	2/6/8	

Approved and Baselined CCBD 301-78-0281 dated 3/6/78

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CONTR NO. NAS 8-32036

PREPARATION L.D. Larsen

DSGN CHK

DWG CHK

DSGN APPROVAL

INTERNATIONAL BUSINESS MACHINES CORP.
FEDERAL SYSTEMS DIVISION
HUNTSVILLE, ALABAMA 35807

TITLE
INSTRUMENTATION PROGRAM-
IBM SYSTEM 1 A

SIZE	CODE IDENT NO.	DWG NO.
A	20234	-IP-7933616

SCALE | WT | SHEET 1 of 29

INTRODUCTION

THIS DOCUMENT DEFINES AND CONTROLS THE MEASURING REQUIREMENTS AND INSTRUMENTATION SYSTEM APPLICATIONS FOR A SOLAR HEATING AND COOLING OPERATIONAL SITE.

THE SECTIONS OF THIS DOCUMENT ARE DESCRIBED AS FOLLOWS:

1. PREAMBLE SECTION — CONTAINS DESCRIPTIONS, EXPLANATIONS, INSTRUCTIONS AND DIAGRAMS NECESSARY TO UNDERSTAND THIS DOCUMENT AND THE APPLICATION OF THE DATA COLLECTION SYSTEM TO A SPECIFIC SITE.

2. INSTRUMENTATION COMPONENTS SECTION — LISTS ALL HARDWARE ELEMENTS OF THE DATA COLLECTION EQUIPMENT NOT SUBSEQUENTLY LISTED IN THE MEASUREMENTS SECTION.

3. MEASUREMENTS SECTION — LISTS ALL MEASUREMENTS WHICH ORIGINATE IN A SOLAR HEATING AND COOLING OPERATIONAL SITE WITH APPROPRIATE INFORMATION FOR EACH MEASUREMENT.

TABLE OF CONTENTS

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MEASUREMENTS SECTION	21

PREAMBLE SECTION

INSTRUMENTATION PROGRAM AND COMPONENTS LIST: IBM SYSTEM 1A
IP 7933616

8/9/77
REV A

OPERATIONAL SITE IDENTIFICATION

1. SITE NAME: IBM SYSTEM 1A
2. PON: NA
3. SITE NUMBER: 0004
4. SITE SDAS TELEPHONE NUMBER: 205-536-0236
5. SITE SDAS COMPUTER ADDRESS: 021
6. SITE ADDRESS: 2809 BURKE ROAD, S.W. (PARALLEL ACCESS OFF TRIANA)
7. LOCATION: HUNTSVILLE, ALA
8. SYSTEM DESIGNER: IBM CORPORATION
9. SYSTEM TYPE: HEATING/HOT WATER
10. FLUID MEDIA: AIR

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ASSOCIATED DOCUMENTS

1. SOLAR HEATING AND COOLING INSTRUMENTATION INSTALLATION GUIDELINES, OCTOBER 1, 1977.

2. [X] SITE DATA ACQUISITION SUBSYSTEM PERFORMANCE SPECIFICATION, MAY 14, 1976, IBM NO. 7932905.
   [ ] SITE DATA ACQUISITION SUBSYSTEM MODEL II, PERFORMANCE SPECIFICATION, 7934354.
   [ ] SITE DATA ACQUISITION PERFORMANCE SPECIFICATION. ACUREX MODEL.

3. CENTRAL DATA PROCESSING SOFTWARE PERFORMANCE SPECIFICATION, JULY 28, 1976, IBM NO. 7933251.

4. THERMAL DATA REQUIREMENTS AND PERFORMANCE EVALUATION PROCEDURES FOR THE NATIONAL SOLAR HEATING AND COOLING DEMONSTRATION PROGRAM, AUGUST, 1976 (NBSIR 76-1137).

5. JUNCTION BOX PERFORMANCE SPECIFICATION, OCTOBER 26, 1976, IBM NO. 7933446.

6. ON SITE MONITOR (OSM) OPERATION MANUAL, OCTOBER 17, 1977, IBM NO. 7934365.

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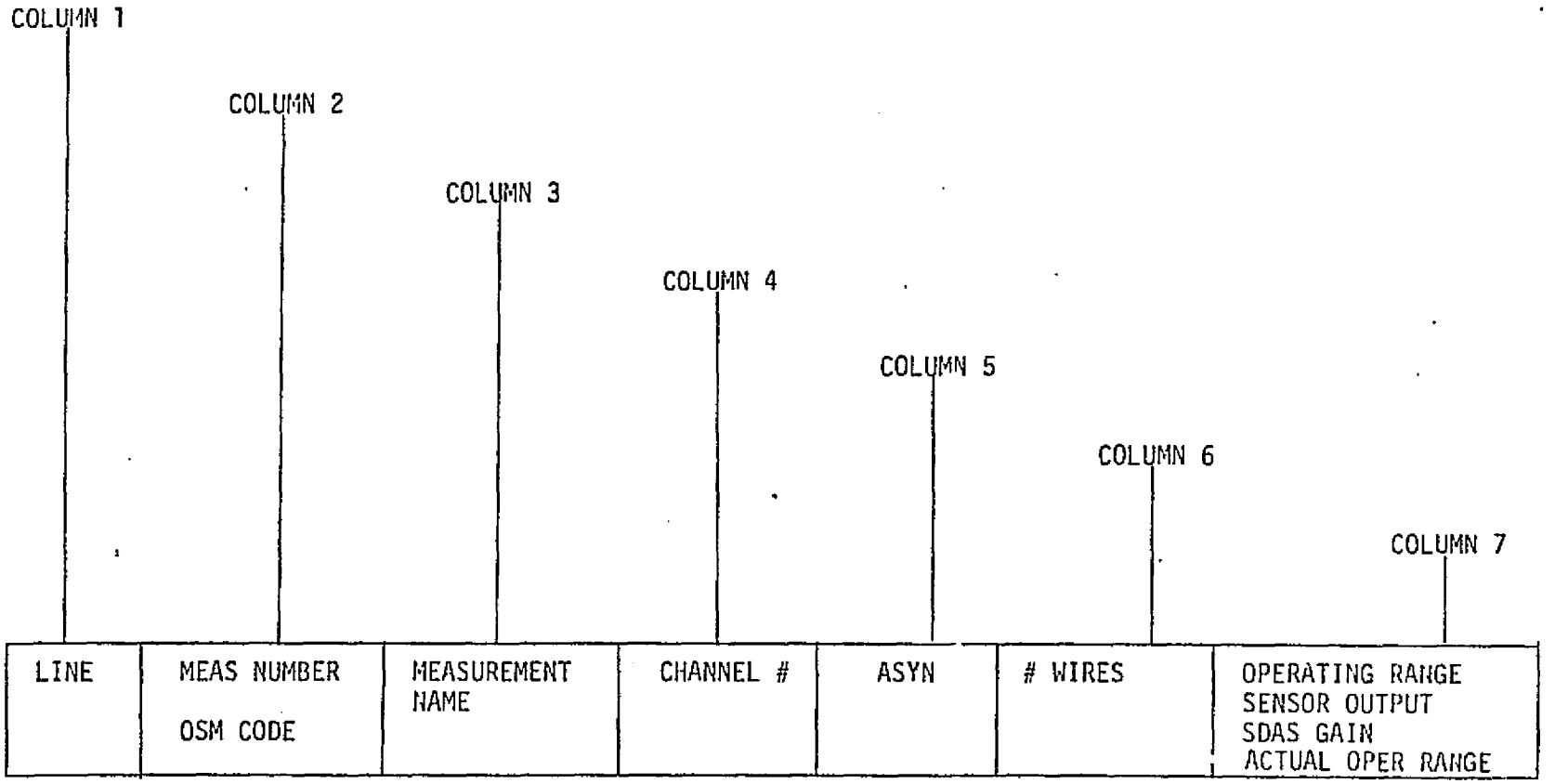
MEASUREMENTS LEGEND

THE LEGEND FOR THE DATA LISTED IN THE MEASUREMENTS SECTION OF THIS DOCUMENT IS AS FOLLOWS:



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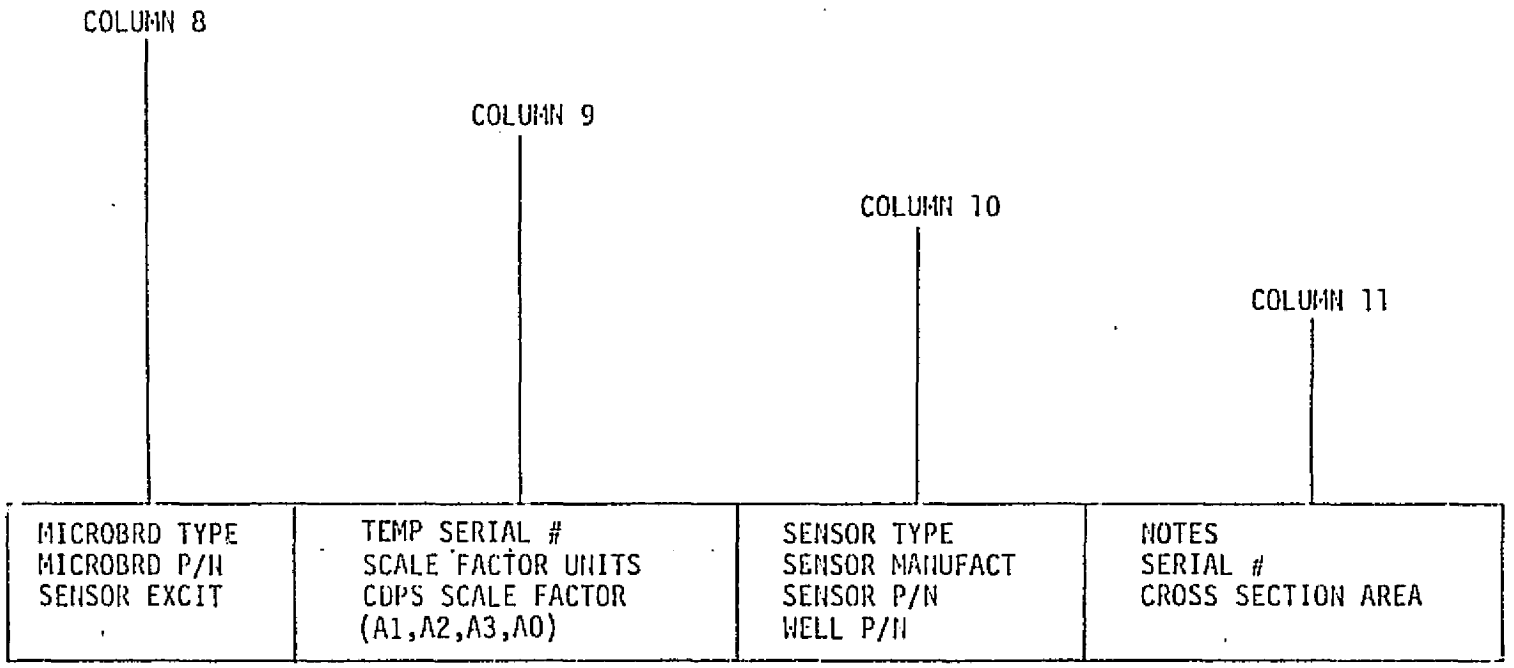
MEASUREMENTS LEGEND (CONTINUED)



THE COLUMN HEADINGS ARE DEFINED ON THE FOLLOWING SHEETS.

8

COLUMN 1. LINE NUMBER

THIS COLUMN IS USED FOR AUTOMATIC PRINTOUT DATA CONTROL AND LINE IDENTIFICATION.

COLUMN 2. (MULTIPLE DATA SETS)

THIS COLUMN CONTAINS TWO DATA SETS AS DEFINED BELOW:

MEAS NUMBER. THE FIRST LINE OF THIS COLUMN LISTS EACH MEASUREMENT WHICH IS IDENTIFIED BY A UNIQUE ALPHANUMERIC CODE CONSISTING OF TEN CHARACTERS AS FOLLOWS:

FIELD NO.	1	2	3	4
MEASUREMENT NO.	XY	001	-	0001

PARAMETER TYPE

PARAMETER SEQUENCE

SEPARATOR

SITE IDENTIFIER

AN ASTERISK (*) FOLLOWING THE MEASUREMENT NUMBER DENOTES A CHANGE FROM THE PREVIOUS RELEASE.

OSM CODE. THE SECOND LINE OF THIS COLUMN LISTS THE ON SITE MONITOR SWITCH SETTING TO DISPLAY ENGINEERING UNIT DATA. THIS IS TO BE USED WITH ASSOCIATED DOCUMENT 6 AND THE GENERAL NOTES ON PAGE 16 OF THIS DOCUMENT.

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A. FIELD NO. 1 — PARAMETER TYPE

CODE	PARAMETER	UNITS	ABB
D D	WIND DIRECTION SWITCH	DEGREES - AZIMUTH DEGREES - ON/OFF	DEG DEG
EP	ELECTRICAL POWER	KILOWATTS	KW
F F	FLOWRATE (NATURAL GAS) FLOWRATE (FUEL OIL)	$FEET^3$/MINUTE GAL/MINUTE	SCFM GPM
I	SOLAR FLUX	BTU PER $FOOT^2$ X HOUR	BTU/FT^2 - HR
RH	HUMIDITY	PERCENT	PER
SP	SPARE	N/A	N/A
T	TEMPERATURE	DEGREES FAHRENHEIT	DEG F
TD	DIFFERENTIAL TEMPERATURE	DEGREES FAHRENHEIT	DEG F/DT
W W	FLOWRATE (LIQUID) FLOWRATE (AIR)	GALLONS PER MINUTE, CUBIC FEET PER MINUTE	GPM CFM
V	WIND SPEED	MILES PER HOUR	MPH
PD	DIFFERENTIAL PRESSURE	POUNDS PER SQ. INCH	PSI

B. FIELD NO. 2 — PARAMETER SEQUENCE

A NUMERIC GROUPING WHICH DESIGNATES THE SEQUENTIAL NUMBER OF A MEASUREMENT WITHIN EACH SUBSYSTEM. THE SEQUENTIAL NUMBER OF EACH MEASUREMENT CONFORMS TO THE PATTERN ESTABLISHED IN FIGURE 3-1 OF SHC-1006. SEQUENTIAL NUMBER ALLOCATIONS ARE AS FOLLOWS:

NUMERIC SEQUENCE	SUBSYSTEM
001-099	CLIMATOLOGICAL
100-199	COLLECTOR
200-299	THERMAL STORAGE
300-399	DOMESTIC HOT WATER
400-499	SPACE HEATING
500-599	SPACE COOLING
600-699	BUILDING/LOAD

C. FIELD NO. 3 — SEPARATOR

FOR NUMERIC CLARITY.

D. FIELD NO. 4 — SITE IDENTIFIER

A NUMERIC GROUPING WHICH DESIGNATES THE SITE IN WHICH THE MEASUREMENT IS LOCATED.

COLUMN 3. MEASUREMENT NAME

THIS COLUMN LISTS THE MEASUREMENT NAME USED TO DESCRIBE THE DATA SOURCE.

COLUMN 4. CHANNEL #

THIS COLUMN DEFINES THE SDAS CHANNEL ASSIGNED TO EACH MEASUREMENT (2 — 48). CHANNEL 1 IS RESERVED FOR AN SDAS INTERNAL CALIBRATION OFFSET MEASUREMENT.

COLUMN 5. ASYN

THIS COLUMN DEFINES EACH MEASUREMENT WHICH IS ASYNCHRONOUSLY SAMPLED AND IS INDICATED BY THE LETTER "A". THESE MEASUREMENTS ARE SAMPLED EACH 32 SECONDS WITH THE AVERAGED VALUE PER 5 MINUTES MAINTAINED FOR TRANSMISSION. SYNCHRONOUSLY SAMPLED MEASUREMENTS ARE READ ONCE PER 5 MINUTES AND ARE IDENTIFIED BY THE "—" SYMBOL.

COLUMN 6. # WIRES

THIS COLUMN DEFINES THE NUMBER OF WIRES PER CHANNEL USED IN THE SDAS. EITHER 3 WIRE OR 2 WIRE CHANNELS ARE AVAILABLE VIA A PRE-DEFINED CONFIGURATION.

COLUMN 7. (MULTIPLE DATA SETS)

THIS COLUMN CONTAINS FOUR DATA SETS AS DEFINED BELOW:

OPERATING RANGE - THE FIRST LINE OF THIS COLUMN DESCRIBES THE OPERATING RANGE OF THE PARAMETER IN ENGINEERING UNITS.

SENSOR OUTPUT RANGE - THE SECOND LINE OF THIS COLUMN DESCRIBES THE OUTPUT RANGE IN VOLTS OF THE SENSOR.

SDAS GAIN - THE THIRD LINE OF THIS COLUMN DESCRIBES THE SDAS GAIN SELECTED FOR EACH CHANNEL.

ACTUAL OPER RANGE - THE FOURTH LINE OF THIS COLUMN IS APPLICABLE TO ABSOLUTE TEMPERATURES ONLY (AFTER CORRECTION COEFFICIENTS ARE APPLIED.)

COLUMN 8. (MULTIPLE DATA SETS)

THIS COLUMN CONTAINS THREE DATA SETS AS DEFINED BELOW:

MICROBRD TYPE - THE FIRST LINE OF THIS COLUMN DESCRIBES THE TYPE OF MICROBOARD USED FOR SIGNAL CONDITIONING OF THE EMPLOYED SDAS CHANNEL.

MICROBRD P/N - THE SECOND LINE OF THIS COLUMN DESCRIBES THE PART NUMBER OF THE MICROBOARD USED FOR SIGNAL CONDITIONING OF THE EMPLOYED SDAS CHANNEL. A MCN-DEFINED MICROBOARD P/N INDICATES THAT THIS CHANNEL SHARES A MICROBOARD WITH ANOTHER CHANNEL WHICH WILL DEFINE THE P/N.

SENSOR EXCIT - THE THIRD LINE OF THIS COLUMN DESCRIBES THE EXCITATION REQUIREMENTS FOR EACH SENSOR, IF REQUIRED.

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COLUMN 9. (MULTIPLE DATA SETS)

THIS COLUMN CONTAINS THREE DATA SETS AS DEFINED BELOW:

TEMP SERIAL #- THE FIRST LINE OF THIS COLUMN DESCRIBES THE TEMPERATURE PROBE SERIAL NUMBER (IF AVAILABLE).

SCALE FACTOR UNITS - THE SECOND LINE OF THIS COLUMN DESCRIBES THE ENGINEERING UNITS MAINTAINED IN THE CDPS FOR EACH MEASUREMENT.

CDPS SCALE FACTOR -- THE THIRD AND FOURTH LINES OF THIS COLUMN DESCRIBE THE NUMERIC SCALE FACTOR(S) USED IN THE CENTRAL DATA PROCESSING SYSTEM (CDPS) TO CONVERT EACH MEASUREMENT TO ENGINEERING UNITS.

COLUMN 10. (MULTIPLE DATA SETS)

THIS COLUMN CONTAINS FOUR DATA SETS AS DEFINED BELOW:

SENSOR TYPE - THE FIRST LINE OF THIS COLUMN LISTS THE TYPE (NAME) OF THE EMPLOYED SENSOR.

SENSOR MANUFACT - THE SECOND LINE OF THIS COLUMN LISTS THE SENSOR MANUFACTURER.

SENSOR P/N - THE THIRD LINE OF THIS COLUMN LISTS THE PART NUMBER OF THE SENSOR.

WELL P/N - THE FOURTH LINE OF THIS COLUMN DESCRIBES THE PART NUMBER OF A THERMAL WELL IF REQUIRED FOR THE DEFINED SENSOR.

COLUMN 11. (MULTIPLE DATA SETS)

NOTES - THE FIRST LINE OF THIS COLUMN DEFINES ANY INFORMATION REQUIRED TO SUPPORT CLARIFICATION OF THE MEASUREMENT.

SERIAL # - THE SECOND LINE OF THIS COLUMN DEFINES AN ITEM UNIQUE SERIAL NUMBER MARKED BY THE MANUFACTURER.

CROSS SECTION AREA - THE THIRD LINE OF THIS COLUMN DEFINES THE CROSS SECTIONAL AREA OF A DUCT IN SQUARE FEET.

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GENERAL NOTES

NOTE 1 - DATA NOT CURRENTLY DEFINED.

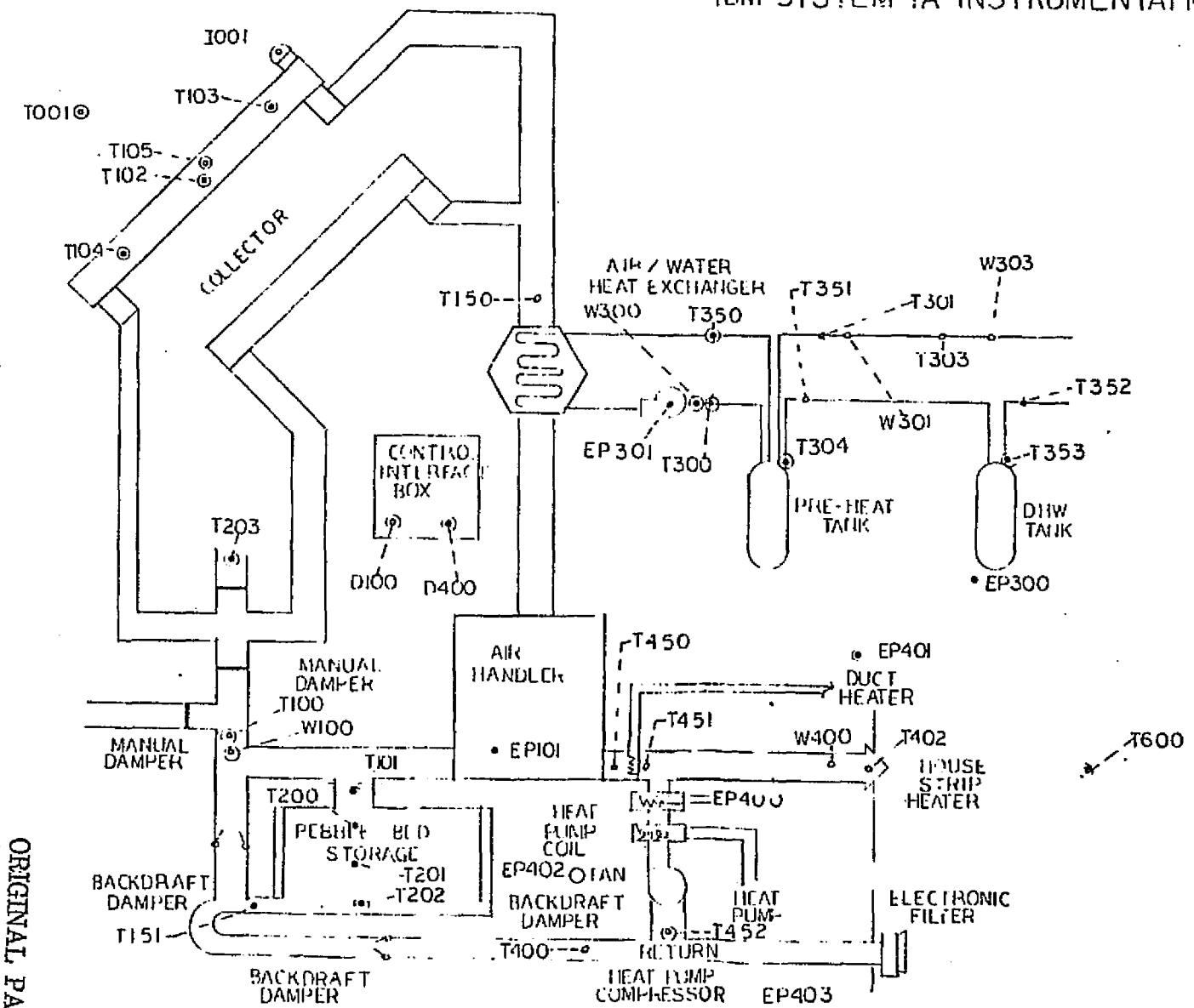
NOTE 2 - ENGINEERING UNIT VALUES MUST BE CALCULATED USING COUNTS & SCALE FACTORS.

NOTE 3 - LIQUID FLOW WITHIN ± 5% OF DISPLAYED VALUE.

NOTE 4 - INSOLATION WITHIN ± 5 BTU OF DISPLAYED VALUE.

NOTE 5 - POWER MEASUREMENT RANGE VALUES & SCALE FACTORS ARE HALVED DUE TO FOUR TURNS THRU TRANSDUCERS.

IBM SYSTEM 1A INSTRUMENTATION SCHEMATIC



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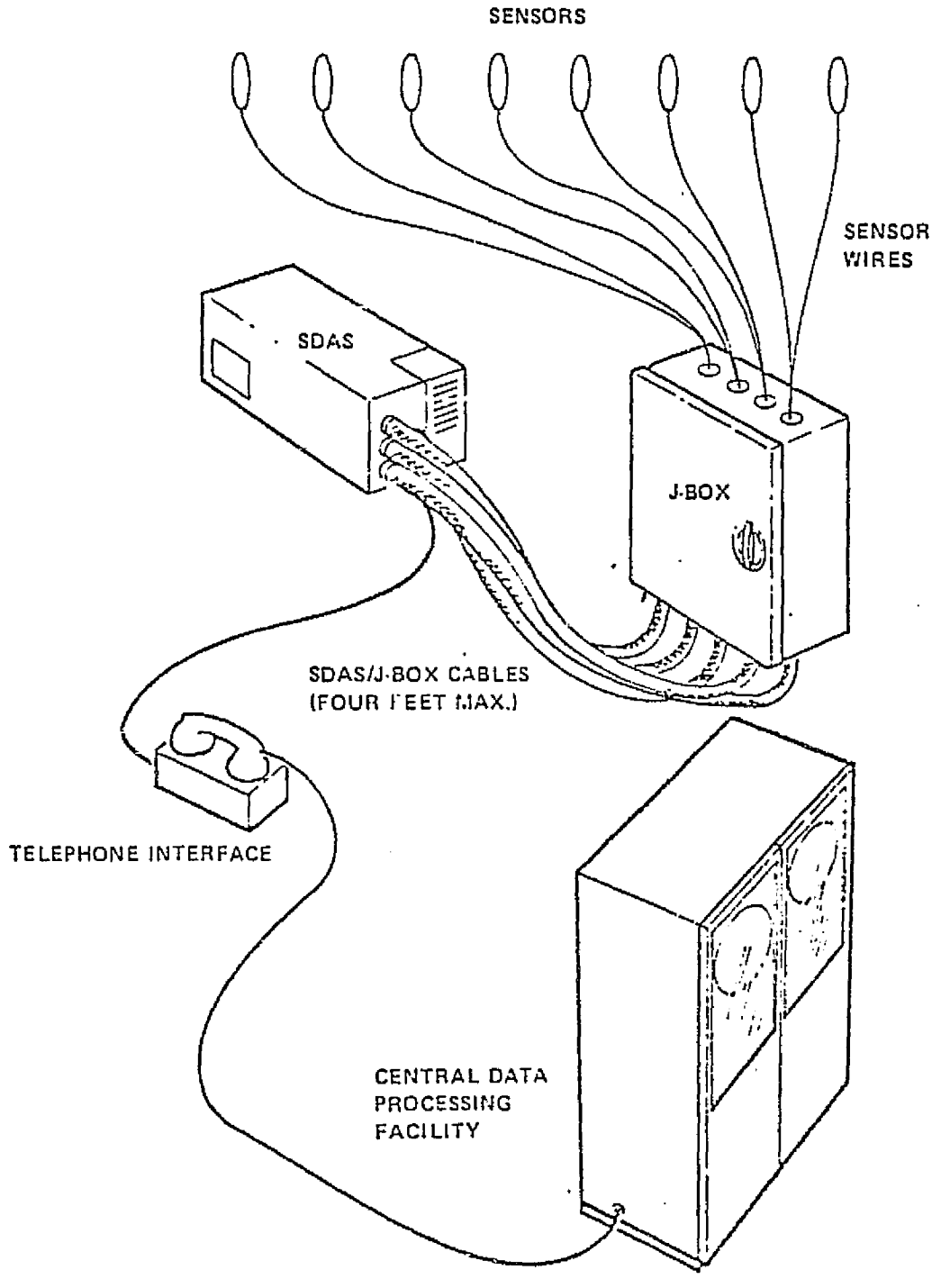

DATA COLLECTION SYSTEM

INSTRUMENTATION COMPONENTS SECTION

G-21

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INSTRUMENTATION PROGRAM AND COMPONENTS LIST --- IBM SYSTEM 1A 8/9/77
IP 7933616
REV A

EQUIPMENT NAME	PART NUMBER	SERIAL NUMBER
JUNCTION BOX	7933575	009
CABLES (J-BOX TO SDAS)		
NO. 1	7933579-1	
NO. 2	7933583	
NO. 3	7933579-2	
NO. 4	7933579-3	
NO. 5	7933578	
SDAS	7932922	007
	N/A	N/A
IBM DRAWING NUMBER	7933616	

G-22

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MEASUREMENTS SECTION

INSTRUMENTATION PROGRAM AND COMPONENTS LIST --- IBM SYSTEM 1A 2/1/78

IP 7933616 REV H

MEASUREMENT SUMMARY

PARAMETER	NUMBER
WIND DIRECTION/SWITCH	--/ 2
ELECTRICAL POWER	7
FLOWRATE (NATURAL GAS)	---
SOLAR FLUX	1
HUMIDITY	---
SPARE	(2)
TEMPERATURE /SPECIAL MEASUREMENTS	27/3
DIFFERENTIAL TEMPERATURE	--
FLOWRATE (LIQUID/AIR)	5
WIND SPEED	---
TOTAL	46

G-24

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REPORT BY CHANNEL ASSIGNMENT

LINE	MEAS NUMBER (SM CODE	MEASUREMENT	CHAN #	A/D SYS #	WIRE PAIR	OPERATING RANGE / SENSOR OUTPUT RANGE / SDAS GAIN / ACTUAL OPER RANGE	MICROBRD TYPE / MICROBRD P/N / SENSOR EXCIT	TEMP SERIAL # / SCALE FACTOR UNITS / CPOS SCALE FACTORS (A1,A2,A3,A0)	SENSOR TYPE / SENSOR MANUFACT / SENSOR P/N / WELL P/N	NOTES / SERIAL # / CROSS SECTION AREA
1	T150 -0004*	COLLECTOR ARRAY OUTLET TEMP	02	3		30/230	DEGF		PRT	(TD1001
2						0-100	MV	BRIDGE	MINCO	
3	0207					50		7932988	S53P85	
4						+32.316 /+239.81		DEGF/BIT		
5								+1940264E-07		
6								+0004525E-09		
7								+0001703E-13		
8								+3731644E-05		
9	EP101-0004	AIR HANDLER POWER	03	A	2	0-1.5	KW	STRAIGHT	WATT XDCR	
10						0-50	MV	7932985	OHIO SEMITRONICS	
11	0342					50		KW/BIT	PC5-19	
12								+0029296E-07		
13	T301 -0004*	DHW MAKEUP TEMP	04	3		30/160	DEGF		PRT	
14						0-100	MV	BRIDGE	MINCO	
15	0401					50		7932990	S57P40Z36	
16						+31.591 /+162.47		DEGF/BIT	F203U60	
17								+1256871E-07		
18								+0002149E-09		
19								+0005204E-14		
20								+3159161E-05		
21	EP302-0004	DHW ELECTRIC POWER	05	A	2	0/1.5	KW	STRAIGHT	WATT XDCR	
22						0-50	MV	7932985	OHIO SEMITRONICS	
23	0542					50		KW/BIT	PC5-19F	
24								+0029295E-07		
25	T303 -0004*	DHW TANK OUTLET TEMP	06	3		30/160	DEGF		PRT	(TD303)
26						0-100	MV	BRIDGE	MINCO	
27	0601					50		7932990	S53P85Z36	
28						+31.411 /+162.05		DEGF/BIT	F203U60	
29								+1256605E-07		
30								+0002139E-09		
31								+0005348E-14		
32								+3141120E-05		
33	T001 -0004*	SOLAR FLUX	07	A	2	0/383.22	BTU/FT2-HR	CAPACITOR	PYRONOM	
34						0-12	MV	7934363	EPPLEY	15220F3
35	0724					50		B/F2-H/BIT	PSP	
36								3.1186294		
37	T304 -0004*	DHW PREHEAT TNK OUTLET TEMP	08	3		30/160	DEGF		PRT	
38						0-100	MV	BRIDGE	MINCO	
39	0301					50		7932990	S53P110Z36	
40						+31.818 /+162.46		DEGF/BIT	F203U80	
41								+1254442E-07		
								+0002144E-09		
								+0005020E-14		
								+3181873E-05		
	SP001-0004	SPARE	09	-	2	N/A		SHORT	N/A	
						N/A		7932938	N/A	
						50		N/A		

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REPORT BY CHANNEL ASSIGNMENT

LINE #	MEAS NUMBER / CSM CODE	MEASUREMENT NAME	CHAN #	A/D BITS	W/P NOT	OPERATING RANGE / SENSOR OUTPUT RANGE / SDAS GAIN / ACTUAL OPER RANGE	MICROBRD TYPE / MICROBRD P/N / SENSOR EXCIT	TEMP SERIAL # / SCALE FACTOR UNITS / CROS SCALE FACTORS (A1,A2,A3,A0)	SENSOR TYPE / SENSOR MANUFACT / SENSOR P/N / MFEL P/N	NOTES / SERIAL # / CROSS SECTION AREA
1	T151 -0004*	RCCK STORAGE	10	3		30/230	DEGF		PRT	(TD101)
2		IN/OUT TEMP				0-100	MV	DEGF/BIT	MINCO	
3	1002					50		+1.987694E-07	S53P55	
4						+33.135 /+241.43		+9.945640E-09		
5								+9.901726E-13		
6								+3.313494E-05		
7	EP400-0004	STRIP HEATER	11	2		0-20	KW		WATT XDCR	
8		POWER				0-50	MV	KW/BIT	OHIO SEMITRONICS	
9	1147					50		+9.390626E-07	PC5-32	
10										
11	T350 -0004*	HX PREHEAT COIL	12	3		30/160	DEGF		PRT	(TD300)
12		OUTLET TEMP				0-100	MV	DEGF/BIT	MINCO	
13	1201					50		+1.253641E-07	S53P55	
14						+31.637 /+262.17		+9.902140E-09	F203028	
15								+9.899335E-14		
16								+3.163722E-05		
17	W100 -0004	COLLECTOR ARRAY	13	2		0-1250	FPM		ANEMOMETER	
18		FLOW				0-5	V	CFM/BIT	SIERRA	
19	1381					1	115 VAC	+3.205254E-07	430-2	2.222
20								+9.908194E-07		
21								+9.901459E-09		
22	T351 -0004*	HX PREHEAT TANK	14	3		30/160	DEGF		PRT	(TD301)
23		OUTLET TEMP				0-100	MV	DEGF/BIT	MINCO	
24	1401					50		+1.254205E-07	S53P55	
25						+31.320 /+261.92		+9.902142E-09	F203028	
26								+9.900309E-14		
27								+3.132088E-05		
28	C100 -0004	ATTIC VENT MODE	15	2		0/1	DIG		SKY VANE	
29		(SWITCH)				0-5	V	DEG/BIT	WEATHER MEASURE	
30	1540					1	+5 VDC	1024.	W101-P-DC560	
31								0.		
32								0.		
33	T352 -0004*	DHW TANK	16	3		30/160	DEGF		PRT	(TD302)
34		OUTLET TEMP				0-100	MV	DEGF/BIT	MINCO	
35	1601					50		+1.252331E-07	S53P55	
36						+31.186 /+261.58		+9.902133E-09	F203028	
37								+9.900521CE-14		
38								+3.118628E-05		

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LINE	MEAS NUMBER / OSM CODE	MEASUREMENT NAME	CHAN #	WIRE #	OPERATING RANGE / SENSOR OUTPUT RANGE / SDAS GAIN / ACTUAL OPER RANGE	MICROBRD TYPE / MICROBRD P/N / SENSOR EXCIT	TEMP SERIAL # / SCALE FACTOR UNITS / CPDS SCALE FACTORS (A1,A2,A1,A0)	SENSOR TYPE / SENSOR MANUFACT / SENSOR P/N / WIRE P/N	NOTES / SERIAL # / CROSS SECTION AREA
1	W301 -0004*	DHW MAKEUP	17	2	0/6.78	GPM	STRAIGHT	FLOW METER	
2		FLOW			0=10	MV	7932985	RAMAPO	S/N4520
3	1753				50	+5 VDC	+6700266E-07 SOCT	MKV-3/4-J07	
4									
5	T450 -0004*	SOLAR HEATING	18	3	30/239	DEGF	BRIDGE	PRT	(TD4001
6		OUTLET TEMP			0-100	MV	7932988	MINCO	
7	1802				50		DEGF/BIT	S57P85	
8					+31.642 /+239.43		+1992527E-07		
9							+0004542E-09		
10							+0001411E-13		
11	FP401-0004	DUCT HEATER	19	2	0-20	KW	+3168289E-05 STRAIGHT	WATT XDCR	
12		POWER			0-50	MV	7932985	OHIO SEMITRONICS	
13	1947				50		KW/BIT	PCS-32F	
14							+0390625E-07		
15	T451 -0004*	SOLAR AUX	20	3	30/233	DEGF	BRIDGE	PRT	(TD4011
16		OUTLET TEMP			0-100	MV	7932988	MINCO	
17	2002				50		DEGF/BIT	S53P85	
18					+32.477 /+240.27		+1982477E-07		
19							+0004535E-09		
20							+0001714E-13 +3249794E-05		
21	W300 -0004*	DHW SOLAR	21	2	0/2.99	GPM	STRAIGHT	FLOW METER	
22		TANK FLOW			0=10	MV	7932985	RAMAPO	S/N4519
23	2150				50	+5 VDC	+2954834E-07 SOCT	MKV-3/4-J07	
24									
25	T452 -0004*	AUX RETURN	22	3	30/160	DEGF	BRIDGE	PRT	(TD4021
26		AIR TEMP			0-100	MV	7932990	MINCO	
27	2201				50		DEGF/BIT	S53P150Z36	
28					+31.729 /+161.80		+1749217E-07		
29							+0002124E-09		
30							+0000332E-14 +3172942E-05		
31	SM602 -0004*	SDAS 5V SUPPLY	23	2	0/5.5	VOLTS			(D990)
32					0-5	V	BRIDGE	VOLTS/BIT	
33	2310				1		7932939	0.+.0053763	
34									
35	T401 -0004*	OUTSIDE AMBIENT	24	3	-20/120	DEGF	BRIDGE	PRT	
36		TEMP			0-100	MV	7932986	MINCO	
37	2400				50		DEGF/BIT	S53P85	
38					-19.912 /+121.47		+1356782E-07		
39							+0002412E-09		
40							+0006350E-14 -1991241E-05		

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LINE	MEAS NUMBER / DSM CODE	MEASUREMENT NAME	CHAN #	A/D BOARD #	WIRE PAIR #	OPERATING RANGE / SENSOR OUTPUT RANGE / SOAC GAIN / ACTUAL OPER RANGE		MICRODRD TYPE / MICRODRD P/N / SENSOR EXCIT	TEMP SERIAL # / SCALE FACTOR UNITS / CPOS SCALE FACTORS (A1,A2,A3,A0)	SENSOR TYPE / SENSOR MANUFACT / SENSOR P/N / WELL P/N	NOTES / SERIAL # / CROSS SECTION AREA
1	W303 -0004	DEW MAKEUP	25	2	07	0-100	GAL	STRAIGHT			
2		FLOW				0-5	V	7932985	GAL/BIT		
3	NOTE 2					1		+ 5 VDC	.0977517		
4											
5	T100 -0004*	COLLECTOR ARRAY	26	3	30-21	30-240	DEGF	BRIDGE		PRT	
6		INLET TEMP				0-100	MV	7932988	DEGF/BIT	MINCO	
7	2602					50			+1973435E-07	S53P85	
8						+31.548 /+238.53			+0006504E-09		
9									+0001660E-13		
10									+3154864E-05		
11	SP008-0004	SPARE	27	2		N/A		SHORT		N/A	
12						N/A		7932938	N/A	N/A	
13						50			N/A		
14											
15											
16	T101 -0004*	ROCK STORAGE	28	3		30-240	DEGF	BRIDGE		PRT	
17		OUT/IN TEMP				0-100	MV	7932988		MINCO	
18	2802					50			DEGF/BIT	S67P85	
19						+30.231 /+238.26			+1984915E-07		
20									+0003566E-09		
21									+0001724E-13		
22	EP403-0004	HEAT PUMP	29	A 2		0-10	KW	STRAIGHT	+3021108E-05	WAIT XDCR	
23		COMPRESS PWR				0-50	MV	7932985	KW/BIT	OHIO SEMITRONICS	
24	2946					50			+0195312E-07	PC5-29	
25											
26	T102 -0004*	MIDDLE COLL ARS	30	3		30-450	DEGF	BRIDGE		PRT	
27		SUR-TMP(MID)				0-100	MV	7932987	DEGF/BIT	MINCO	
28	3003					50			+3915971E-07	S32A	
29						+31.909 /+449.56			+0001499E-08		
30									+0001179E-12		
31									+3199876E-05		
32	C400 -0004	SUMMER OPER	31	2	07	0-1	DSC	STRAIGHT		SKY VANE	
33		MODE (SWITCH)				0-5	V	7932985	DEG/BIT	WEATHER MEASURE	
34	3130					1		+5 VDC	1024.	W101-P-DC540	
35									0.		
36									0.		
37	T103 -0004*	MIDDLE COLL ARS	32	3		30-450	DEGF	BRIDGE		PRT	
38		SUR-TEMP(UP)				0-100	MV	7932987	DEGF/BIT	MINCO	
39	3203					50			+3915971E-07	S32A	
40						+31.909 /+449.56			+0001499E-08		
41									+0001179E-12		
42									+3199876E-05		

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LINE #	MEAS NUMBER / DSM CODE	MEASUREMENT NAME	CHAN #	ASYM	WIRE	OPERATING RANGE / SENSOR OUTPUT RANGE / SDAS GAIN / ACTUAL OPER RANGE	MICROBRD TYPE / MICROBRD P/N / SENSOR EXCIT	TEMP SERIAL # / SCALE FACTOR UNITS / CPOS SCALE FACTORS (A1,A2,A3,A0)	SENSOR TYPE / SENSOR MANUFACT / SENSOR P/N / WELL P/N	NOTES / SERIAL # / CPOSS SECTION AREA
1	EP301-0004	CHN CIRCULATING PUMP POWER	33	A	2	0-.5	KW	STRAIGHT		WATT XDCR
2						0-50	MV	7932985		OHIO SEMITRONICS
3	3340					50		KW/BIT		PCS-1
4								+0009765E-07		
5	T600 -0004✱	INSIDE AMBIENT TEMP	34	-	3	30-160	DEGF	BRIDGE		PRT
6						0-100	MV	7932990		MINCO
7	3401					50		DEGF/BIT		S53P85
8						+33.392	/+140.67	+1269515E-07		
9								+0002154E-09		
0								+0000549E-14		
								+3338249E-05		
11	EP402-0004	CIRCULATING FAN POWER	35	A	2	0-1	Kw	STRAIGHT		WATT XDCR
12						0-50	MV	7932985		OHIO SEMITRONICS
13	3541					50		KW/BIT		PCS-2
14								+0019531E-07		
15	T104 -0004✱	MIDDLE COLL ABS SUR-TMP(LOW)	36	-	3	30-450	DEGF	BRIDGE		PRT
16						0-100	MV	7932987		MINCO
17	3603					50		DEGF/BIT		S32A
18						+31.999	/+449.55	+3915971E-07		
19								+0001499E-08		
20								+0001179E-12		
								+3199976E-05		
21	SM600 -0004✱	SDAS S/C#1 15V	37	-	2	0/15.5	VOLTS	BRIDGE	VOLTS/BIT	(D991)
22						0-5	MV	7932939	0.+.0151515	
23	3730					1				
24										
25	T105 -0004✱	MIDDLE COLL ABS SUR-TMP(SDE)	38	-	3	30-450	DEGF	BRIDGE		PRT
26						0-100	MV	7932987		MINCO
27	3803					50		DEGF/BIT		S32A
28						+31.999	/+449.55	+3915971E-07		
29								+0001499E-08		
30								+0001179E-12		
								+3199976E-05		
31	SM601 -0004✱	SDAS S/C#2 15V	39	-	2	0/15.5	VOLTS	BRIDGE	VOLTS/BIT	(D992)
32						0-5	V	7932939	0.+.0151515	
33						1				
34										
35	T200 -0004✱	ROCK STORAGE TEMP - TOP	40	-	3	30-160	DEGF	BRIDGE		PRT
36						0-100	MV	7932990		MINCO
37	4001					50		DEGF/BIT		S53P700
38						+32.000	/+150.35	+1333001E-07		
39								+0002069E-09		
40								+0004839E-14		
								+3199993E-05		

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LINE	MEAS NUMBER / PEM CODE	MEASUREMENT NAME	C # / A S / W I / R	OPERATING RANGE / SENSOR OUTPUT RANGE / SDAS GAIN / ACTUAL OPER RANGE	MICROBRD TYPE / MICROBRD P/N / SENSOR EXCIT	TEMP SERIAL # / SCALE FACTOR UNITS / CROSS SCALE FACTORS (A1,A2,A3,A0)	SENSOR TYPE / SENSOR MANUFACT / SENSOR P/N / WELL P/N	NOTES / SERIAL # / CROSS SECTION AREA
1	W400 -0004	AIR DUCT OUTLET	41 - 2	0-1250	FPM	STRAIGHT	ANEMOMETER	
2		FLOW		0-5	V	7932985	SLURRA	
3	4181			1		115 VAC	430-2	2.007
4								
5						+2805114E-07 +0007400E-07 +0001318E-09		
6	T201 -0004*	ROCK STORAGE	42 - 3	30-160	DEGF	BRIDGE	PRT	
7		TEMP - MIDDLE		0-100	MV	7932990	MINCO	
8	4201			50			553P700	
9				+32.000 /+160.35				
10						DEGF/BIT +1234001E-07 +0002960E-09 +0004839E-14 +3199993E-05		
11								
12	T202 -0004*	ROCK STORAGE	43 - 3	30-160	DEGF	BRIDGE	PRT	
13		TEMP - BOTTOM		0-100	MV	7932990	MINCO	
14	4301			50			553P700	
15				+32.000 /+160.35				
16						DEGF/BIT +1233001E-07 +0002969E-09 +0004839E-14 +3199993E-05		
17								
18	T203 -0004*	ATTIC TEMP	44 - 3	30-160	DEGF	BRIDGE	PRT	
19				0-100	MV	7932990	MINCO	
20	4401			50			553P95	
21				+32.999 /+164.57				
22						DEGF/BIT +1263402E-07 +0002147E-09 +0005331E-14 +3299023E-05		
23								
24	T300 -0004*	HW PREHEAT PUMP	45 - 3	30-160	DEGF	BRIDGE	PRT	
25		INLET TEMP		0-100	MV	7932990	MINCO	
26	4501			50			557P55	
27				+31.636 /+163.04			T203U28	
28						DEGF/BIT +1261745E-07 +0002174E-09 +0004912E-14 +3163675E-05		
29								
30	T401 -0004*	COLD WATER	46 - 3	30-160	DEGF	BRIDGE	PRT	
31		SUPPLY TEMP		0-100	MV	7932990	MINCO	
32	4601			50			557P55	
33				+32.115 /+163.55			T203U28	
34						DEGF/BIT +1261038E-07 +0002165E-09 +0005251E-14 +3213576E-05		
35								
36	T400 -0004*	SOLAR RETURN	47 - 3	30-160	DEGF	BRIDGE	PRT	
37		AIR TEMP		0-100	MV	7932990	MINCO	
38	4701			50			557P85	
39				+31.999 /+162.97				
40						DEGF/BIT +1257735E-07 +0002154E-09 +0004974E-14 +3199985E-05		
41								

REPORT BY CHANNEL ASSIGNMENT

LINE #	MEAS NUMBER / CSM CODE	MEASUREMENT NAME	CHAN #	WIRE #	OPERATING RANGE / SENSOR OUTPUT RANGE / SOAS GAIN / ACTUAL OPER RANGE	MICROBRD TYPE / MICROBRD P/N / SENSOR EXCIT	TEMP SERIAL # / SCALE FACTOR UNITS / CROS SCALE FACTORS (A1,A2,A3,A0)	SENSOR TYPE / SENSOR MANUFACT / SENSOR P/N / WELL P/N	NOTES / SERIAL # / CROSS SECTION AREA
1	T402 -0004*	SPACE HEATING	48	3	30/160	DEGF		PRT	
2		INLET TEMP			0-100	MV	BRIDGE	HINCO	
3	4801				50		DEGF/BIT	S57P05	
4					+32.541 /+163.29		+1.255592E-07		
5							+0.002140E-09		
6							+0.005249E-14		
							+3.294160E-05		

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REVISIONS

CHK	ENGRG NOTICE	LTR	DESCRIPTION	DATE	APPROVED

DWG NO. 7933445

DCN-1

Revision B
Date: February 11, 1977

CDRL Item No.s - 2a
-13

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CONTR NO. NAS8-32036	INTERNATIONAL BUSINESS MACHINES CORP. FEDERAL SYSTEMS DIVISION HUNTSVILLE, ALA. 35807
PREPARATION D.G. Daniel	TITLE Verification Plan/Procedure for Prototype Solar Energy Heating and Hot Water System Model No. 1
DSGN CHK	
DWG CHK	
DSGN APPROVAL V.H. Johnson	SIZE A / CODE IDENT NO. / DWG NO. 7933445
	SCALE / WT / SHEET

955-1685-0

1.0 PURPOSE

1.1 The purpose of this document is to present the plan/procedure for verifying the requirements of Performance Specification for prototype solar energy heating and hot water system model number 1.

2.0 SCOPE

2.1 This document describes the plan/procedure for performing prototype systems verification and includes development, qualification, and acceptance verification. One system of each design shall be physically tested in accordance with this document. All subsequent systems shall be verified by analysis, similarity and inspections.

3.0 APPLICABLE DOCUMENTS

The following documents form a part of this plan to the extent specified herein:

- o Interim Performance Criteria for Solar Heating and Combined Heating/Cooling Systems and Dwellings, HUD - January 1, 1975

- o Performance Specification for Prototype Heating and Hot Water System Model No. 1;

4.0 VERIFICATION APPROACH

4.1 Prototype system verification to the requirements of the system performance specification and interim performance criteria will be accomplished in three verification phases--development, qualification, and acceptance. The verification methods utilized for system verification will be similarity, analysis, inspection, demonstration and test.

Prototype system verification will commence with a detailed analysis of all system hardware, components, and subsystems and progress through system evaluation and testing. Figure I of this plan depicts a summary flow for system verification.

A detailed system test procedure for performing the test requirements of this document will be prepared and submitted to MSFC for review and approval. This procedure will describe the methods and procedures for conducting prototype system test on the MSFC system test breadboard facility.

Following completion of verification program, a final system verification report will be prepared and submitted to MSFC. Report will contain all information pertinent to system verification.

5.0 DEVELOPMENT VERIFICATION REQUIREMENTS

5.1 Hardware/Component/Subsystem Verification - All hardware, components and subsystems that comprise the prototype system shall be verified to be in accordance with the requirements of the prototype system performance specification and the interim performance criteria. Verification of hardware, components, and subsystems will be accomplished by engineering analysis, similarity, inspection, demonstration and/or testing methods.

Subsystem test evaluation will be conducted on the system collectors, controller, and data acquisition system. All other prototype system subsystems, hardware and components will be verified individually by analysis and/or during prototype system verification.

5.2 System Development Verification - Development verification will be conducted on prototype system M/N 1 to ensure that system will perform to the requirements of the system performance specification and interim performance criteria. Development verification will consist of the following:

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- o Analysis of hardware, component, and subsystem evaluation data for compliance to system performance specification and interim performance criteria requirements.

- o Analysis of system design for compliance to system performance specification and interim performance criteria requirements.

- o System testing on MSFC System Test Breadboard Facility. Tests to be conducted are as follows:

  - System operational functional test

  - System capacity for control, energy storage, and distribution to load at known simulated energy inputs.

  - System capacity for control, energy collection, storage, and distribution to load at outside ambient weather conditions.

5.2.1 System Operational Functional Test. A system operational functional test shall be conducted on prototype system M/N 1. Operational functional test shall consist of the following:

- Operational test of system blowers

- Operational test of system damper valves

- System check for air leaks

- Measurement of flow rate and pressure drop across collectors

- Measurement of flow rate and head pressure of each blower in each system operational mode

- Operational test of domestic hot water subsystem (operation of pump, valves, controller)

- Pressure test of domestic hot water subsystem

5.2.1.1 System Operational Functional Test Procedure

(a) Install prototype system on breadboard test stand in accordance with test setup schematics and system drawings and verify that simulated transport ducting sizes and lengths are the same as those identified in the prototype system test procedures.

(b) Make appropriate electrical connections to prototype system air handler, blowers, controller and hot water subsystem. Connections shall be made in accordance with system drawings and shall contain a quick disconnect.

(c) Connect hot water subsystem to city water supply and fill domestic hot water tank, preheat tank, and water lines.

(d) Pressurize hot water subsystem to 150 psi and check for leaks. Special emphasis shall be placed on leak testing soldered joints and mechanical connections. There shall be no leaks.

(e) Activate system blower and manually override system controller to provide air flow through collectors to system storage and back through collectors.

(f) Check system for air leaks and exercise effort to make system air tight as practical. Leaks on collectors shall be sealed with butyl tape and duct leaks with duct tape.

C.D.

(g) During operational mode of step (e) measure flow rate and pressure drop across collectors and storage.
Nominal flow rate for collectors should be 1200 ± 150 cfm.
Nominal flow rate for storage should be 1200 ± 150 cfm.
Nominal pressure drop across collectors should be .08 ± .01 "H_2O.
Nominal pressure drop across storage should be .18 ± .06 "H_2O.

(h) Manually override system controller to provide air flow through collectors and system load loop (bypass storage) and return to collectors.

(i) During operational mode of step (h) measure flow rate and pressure drop across collectors and load loop.
Nominal flow rate for collectors should be 1200 ± 150 cfm.
Nominal flow rate for load loop should be 1200 ± 150 cfm.
Nominal pressure drop across collectors should be .08 ± .01 "H_2O.
Nominal pressure drop across load loop should be .2 ± .1 "H_2O.

(j) Check load loop and air handler for air leaks and repair any leaks noted.

(k) Manually override system controller to provide air flow from storage to load loop and return to storage.

(l) During operational mode of step (k) measure flow rate and pressure drop across storage.
Nominal flow rate should be 1200 ± 150 cfm.
Nominal pressure drop should be .18 ± .06 "H_2O.

5.2.2 System Test with Simulated Energy Inputs. Prototype system M/N 1 shall be tested to evaluate system capacity for control, storage and distribution to load using controlled simulated energy inputs. Tests shall be performed with simulated energy inputs of 90, 100, 125, 150 and 175°F. Simulated temperatures shall be controlled in the duct area that simulates

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collector outlet as close as practical. Each simulated temperature shall be circulated throughout the system a sufficient amount of time until the system has stabilized at the simulated temperature level. The following evaluations shall be made during system test.

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(a) Time required to raise storage to each simulated temperature level from temperature level of storage at the start of test (temperature vs. time in hours).

(b) Time required to exhaust storage to load to 80°F from each simulated temperature level (temperature vs. time in hours).

(c) BTU supplied to load from storage at each simulated temperature level (Btu/hour vs. time in hours).

(d) Btu supplied to hot water system from simulation at each simulted temperature level (Btu/hour vs. time in hours).

5.2.2.1 Procedure for System Test with Simulated Energy Inputs

Prototype system M/N 1 shall be installed on MSFC test breadboard in accordance with system test schematics and system drawings and subjected to system test using controlled simulated energy inputs. Test shall be conducted with simulated energy inputs of 90, 100, 125, 150 and 175°F. Simulated temperatures shall be controlled in the duct area that simulates collector output as close as practical. Tests shall be conducted as follows:

(a) Place system collector inlet and outlet dampers in the closed position (isolating collectors from system). Set energy simulator to maintain 90°F.

DCN-1

(b) Manually override system controller and allow air to circulate from breadboard energy simulator through system air handler and ducting to storage and return to energy simulator. Allow circulation in this mode until temperature stabilization has occurred throughout the system.

(c) Measure and record the following conditions.

- Temperature drop across system (from simulation to storage

- Time required to raise and stabilize storage temperature to simulation temperature from temperature level of storage at the start of test (temperature vs. time in hours).

(d) Following completion of step (c) manually override system controller and allow air to circulate from storage through air handler and ducting to breadboard load device. Set load device to maintain 70^{0}F and 1200 $\pm$ 150 CFM.

(e) Measure and record the following conditions.

- Temperature drop from storage to load

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- Btu supplied to load from storage (Btu vs. time in hours)

- Time required to exhaust storage to 80^{0}F (temperature vs. time in hours)

(f) Following completion of step (e) manually override system controller and make ducting connection to allow air circulation from simulator through air handler over hot water preheat coil and return to simulator. Apply power to system blower.

(g) Measure and record Btu supplied to domestic hot water system (Btu vs. time in hours). Test for approximately four hours at each simulated temperature level (constant load for hot water system to be supplied from breadboard).

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(h) Repeat steps (b) through (g) at each of the following simulation temperatures: 100, 125, 150, and 175°F.

5.2.3 System Test at Outside Weather Conditions. Prototype system M/N 1 shall be tested to evaluate system capacity for control, energy collection, storage, and distribution to load at outside ambient weather conditions.

Prototype system M/N 1 shall be tesed at outside weather conditions the maximum number of days possible contingent on system delivery schedule and breadboard facility work load. Primary intent of this test is to obtain as much data as possible prior to installing system at demonstration site. The following evaluations shall be made during system testing at outside weather conditions.

(a) Complete records of weather data. (Solar radiation, ambient temperature, wind speed and direction, relative humidity, and cloud cover.) (Weather measurements vs. time of day.)

(b) Total energy collected by solar system per day (Btu vs. time in hours).

(c) Total energy supplied to load per day.

- Direct from collectors (Btu vs. time of day)

- From storage (Btu vs. time of day)

(d) Total energy supplied to hot water subsystem per day (Btu vs. time of day)

(e) Power required to operate solar system per day (watts vs. time of day)

(f) System control functions. (Manual observations).

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(g) System data collection functions (Compare with breadboard instrumentation)

5.2.3.1 Procedure for System Test at Outside Weather Conditions

Prototype system M/N 1 shall be installed on MSFC test breadboard in accordance with system test schematics and system drawings and subjected to system test at outside weather conditions. Test shall be conducted as follows:

(a) Configure the system collectors, storage, air handler, controller, hot water subsystem, and simulated ducting in an active mode and connect system to breadboard load device. (System configuration to simulate actual installation as best practical.)

(b) Apply power to system and allow system to operate in accordance with system control functions (actual intended operation).

(c) Every 15 minutes manually override system controller to demand a system heating load requirement for 15 minutes. (Breadboard heat load shall be adjusted to provide 70°F outlet temperature of load device.

(d) Every two hours during daytime hours a two minute 6 gpm demand shall be imposed on the hot water subsystem. Every six hours during night hours a 2 minute 6 gpm demand shall be imposed on hot water subsystem.

During system test a one-time test will be conducted on the hot water subsystem that simulates total exhaustion of the hot water tank and a resultant evaluation of the time required to recharge the hot water subsystem preheat tank.

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NOTE: As the test progresses the time sequence, duration and parameters of steps (c) and (d) may be adjusted by the test conductor to provide a more appropriate test commensurate with local weather conditions. Any adjustments will be properly noted and recorded.

(e) Allow system to operate the maximum number of days practical. Duration of testing will be determined by the test conductor with direction from MSFC SIMS contract COR or his designated representative.

(f) The following data measurements shall be made and recorded during system testing:

Measurement	Parameter
- Solar radiation	Btu/hour/ft.^{2} vs. time of day
- Ambient temperature	^{o}F vs. time of day
- Wind speed/direction	mph/direction vs. time of day
- Relative humidity	% vs. time of day
- Cloud cover	cloud cover vs. time of day
- Collector inlet temperature	^{o}F vs. time of day in hours
- Collector outlet temperature	^{o}F vs. time of day in hours
- Collector absorber temperature	^{o}F vs. time of day in hours
- Collector delta temperature	^{o}F vs. time of day in hours
- Storage inlet temperature	^{o}F vs. time of day in hours
- Storage outlet temperature	^{o}F vs. time of day in hours
- (3) Internal storage temperature	^{o}F vs. time of day in hours
- System air inlet temperature to load	^{o}F vs. time of day in hours

Measurement	Parameter
- System air outlet temperature from load	^{o}F vs. time of day in hours
- Load device inlet temperature	^{o}F vs. time of day in hours
- Load device outlet temperature	^{o}F vs. time of day in hours
- Hot water coil inlet temperature	^{o}F vs. time of day in hours
- Hot water coil outlet temperature	^{o}F vs. time of day in hours
- Hot water preheat tank temperature	^{o}F vs. time of day in hours
- City water supply temp to hot water subsystem	^{o}F vs. time of day in hours
- Hot water system outlet temperature	^{o}F vs. time of day in hours
- System temporary shelter temperature	^{o}F vs. time of day in hours
- Air flow thru collectors	cfm vs. time of day in hours
- Air flow thru storage	cfm vs. time of day in hours
- Air flow thru load	cfm vs. time of day in hours
- Liquid flow thru load device	gpm vs. time of day in hours
- Liquid flow hot water load	gpm vs. time of day in hours
- Collection loop blower power	watts vs. time of day in hours
- System load loop blower power	watts vs. time of day in hours
- System damper motors power	watts vs. time of day in hours
- Hot water subsystem power	watts vs. time of day in hours

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(g) Test data taken from the measurements identified in step (f) shall be provided in plot form.

5.3 System Development Verification Hardware - System development verification analysis will be performed on the total system design. System development verification testing will be conducted on a partially configured system utilizing simulated system energy transport ducting and major subsystems of the prototype system. This method of test evaluation is dictated by the technical aspects of each individual system and the test breadboard facility design. This method is both technically sound and cost effective. Cost effectiveness will result primarily from less hardware handling and no utilization of prototype system auxiliary energy. Auxiliary energy subsystem will be thoroughly evaluated by engineering analysis.

Prototype system development verification testing will be conducted utilizing the following system configured hardware and subsystems:

- Solar collectors (total system complement)
- Air handling device (transport blowers)
- Storage subsystem
- Hot water subsystem
- System controller
- Simulated system ductwork
- Data collection sensors

During system test the above prototype system hardware (excluding solar collectors) shall be housed in a temporary shelter with the shelter ambient temperature maintained between 35^{o} and 100^{o}F. This will prevent the solar system from being exposed to harsh environments and will provide an approximate simulation of the service use environment.

5.4 System Development Verification Test Procedures - Test procedures for conducting prototype system verification testing will be prepared and submitted to MSFC for approval. These procedures will describe the hardware configuration for testing, detailed test methods and procedures, sketches of test setup, test time, limits, data and report

requirements, and all other procedural information pertinent t test evaluation program.

5.5 System Design Changes During Development Verification - Any design changes occurring during development verification will be verified by engineering analysis or test evaluation. Ample data will be provided for each design change to verify that the resultant change meets performance criteria requirements and that the resultant change has no adverse effects on the total system performance.

5.6 Development Verification Data - Test data accumulated during the early stages of development testing will be thoroughly evaluated and assessments will be performed on necessary system design changes. This will assure early design maturity of prototype system M/N 1.

5.7 Development Verification Extent/Level - Development verification program will be conducted to the extent necessary to verify that the final prototype system design meets or exceeds the requirements of the system performance specification and the interim performance criteria or that any requirement which has not been met has been properly dispositioned and MSFC approved by a deviation approval request. Any such deviation from the specified requirements will be documented in the final verification report and will become a part of the prototype system performance specification.

5.8 Additional Development Testing - Additional testing and evaluations other than those specified herein may be accomplished. Additional testing and evaluations will be coordinated with MSFC SIMS contracting officer or his designated representative. Additional testing and evaluation will be properly controlled, documented and reported.

6.0 QUALIFICATION VERIFICATION REQUIREMENTS/PROCEDURE

6.1 Qualification Verification Requirements - Requirements for qualification verification are as follows:

- Verification that the prototype system meets or exceeds the requirements of system performance specification. These requirements are:

  Interim Performance Criteria Requirements
  Government Directed Requirements
  System Identification Requirement

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Site Identification Requirement
System Heating Capacity Requirement
Auxiliary Energy Requirement
Hot Water Requirement
Operating Requirements
System Physical Requirements (Design Life, Weight, Dimensions)

6.2 Qualification Verification Procedures - Procedures for verification of each qualification verification requirement are contained in the following subparagraphs.

6.2.1 Interim Performance Criteria Requirement - An analysis will be conducted on prototype system M/N 1 to satisfy this requirement. Each interim performance criteria requirement will be analyzed individually and recorded on an interim performance criteria certification form. This form will indicate compliance or non-compliance to the requirement and will identify the evaluation method utilized to satisfy the requirement. A sample copy of the interim performance criteria certification form is contained in Appendix I of this document. The certification form when completed will become a part of the final verification report.

6.2.2 Government Directed Requirements - This requirement will be satisfied by an analysis of the directed requirement, prototype system and the system performance specification to verify that the directed requirements have been satisfied.

6.2.3 System Identification Requirement - This requirement will be satisfied by review of performance specification and the prototype system to verify that the system is properly identified (type, contractor name, system model no.).

6.2.4 Site Identification Requirement - This requirement will be satisfied by review of performance specification to verify that the site for the prototype system is properly identified and described.

6.2.5 System Heating Capacity Requirement - This requirement will be satisfied by an analysis of the prototype system design and the climate conditions anticipated for the selected site at which the prototype system will be located. Test data obtained during system development testing will be utilized to verify the design models for the prototype system.

6.2.6 Auxiliary Energy Requirement - This requirement will be satisfied by an analysis of the prototype system load requirements and the prototype system auxiliary energy subsystem design.

6.2.7 Hot Water Requirement - This requirement will be satisfied by an analysis of the prototype system design and the hot water load requirements specified for the prototype system. Test data obtained during system development testing will be utilized to verify the design models for the hot water subsystem.

6.2.8 Operating Requirements - This requirement will be satisfied by an analysis of the prototype system design and the system operating requirements (maximum power to drive system, average yearly electrical power, water requirements). Test data obtained during system development testing will be utilized to verify the design models for the prototype system.

6.2.9 System Physical Requirements - This requirement will be satisfied by an analysis of the prototype system design and the system physical requirements (design life, weight, dimensions).

6.3 Prototype System Qualification

6.3.1 Qualification verification will consist of a critical analysis of the prototype system design at the start of development verification versus the system design at completion of development verification. An assessment of all changes implemented during

development verification will be made. All test, analysis, and evaluation data originating prior to and during development verification will be analyzed and evaluated to the requirements of the prototype system performance specification and interim performance criteria.

6.3.2 The prototype system will be considered qualification verified when it is determined that the final system design and hardware has met or exceeded the requirements of the system performance specification and the interim performance criteria or that any requirement which has not been met has been properly dispositioned and MSFC approved by a deviation approval request.

6.3.3 The results of qualification verification will be documented and submitted to MSFC in the prototype system verification report.

7.0 ACCEPTANCE VERIFICATION REQUIREMENTS/PROCEDURE

7.1 Acceptance verification will be conducted on prototype system M/N 1 to verify that the system meets all specified requirements. Acceptance verification will consist of the following.

- Inspection of system to verify performance specification and workmanship standards
- Inspection of operational test data and evaluations to verify system performance
- Inspection of acceptance data package
- Inspection of shipping list versus hardware to be delivered
- Inspection of shipping instructions and precautions
- Inspection of documentation required for system (installation, operation, maintenance manuals, system drawings and specifications, etc., in accordance with prototype system performance specification and data package requirements).

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7.2 The results of acceptance verification will be documented and submitted to MSFC in the prototype system verification report.

8.0 PROTOTYPE SYSTEM VERIFICATION HARDWARE DISPOSITION

Following the completion of prototype system development, qualification and acceptance verification program the system hardware shall be removed from the MSFC test breadboard facility. The system collectors, air handling device, system blowers, hot water subsystem, system controller and data collection sensors shall be prepared for shipment to a designated demonstration site. Shipping instructions shall be in accordance with prototype system M/N 1 shipping instructions.

Simulated duct work, rock storage, test brackets and miscellaneous hardware used during system test will be retained at the MSFC breadboard facility for possible future utilization.

9.0 PROTOTYPE SYSTEM VERIFICATION DOCUMENTATION

9.1 Prototype System Test Procedure - Prototype system test procedure for prototype system M/N 1 will be generated utilizing the requirements of this document, prototype system performance specification and drawings. Test procedure will be submitted to MSFC for approval prior to the start of system verification testing. Test procedure shall contain at a minimum the following information.

(a) Identification of hardware/system to be verified (model No., serial No., mfr., size, description, etc.)

(b) Test requirements

(c) Development verification test methods/procedures

(d) Instrumentation and data requirements

(e) Location of tests to be conducted

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(f) Test limits and tolerances

(g) Test equipment to be utilized

(h) Detailed test setup and system configuration sketches

(i) Test reporting procedures

9.2 Verification Report - A final prototype system verification report will be generated following completion of system verification. Final report will be submitted to MSFC and shall contain at a minimum the following:

(a) Summary - resumé of verification results

(b) Purpose of verification and requirements to be verified

(c) Hardware/system identification (model No., serial No., mfr., size, description, etc.)

(d) Summary of verification procedures

(e) Results of development verification

(f) Results of qualification verification

(g) Results of acceptance verification

(h) Definition of analysis conducted

(i) Definition of inspections conducted

(j) Definition of tests conducted

(k) Photographs and/or detailed sketches of test setups

(l) Test data (data sheets, charts, graphs, plots, etc.)

(m) Equipment and facilities used for test

(n) Conclusions and recommendations

10.0 VERIFICATION MATRIX

Cross reference matrix for prototype system M/N 1 verification is contained in Appendix II of this document. This matrix is applicable to system selected for physical testing.

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PROTOTYPE SYSTEM MODEL I VERIFICATION

APPROACH/FLOW

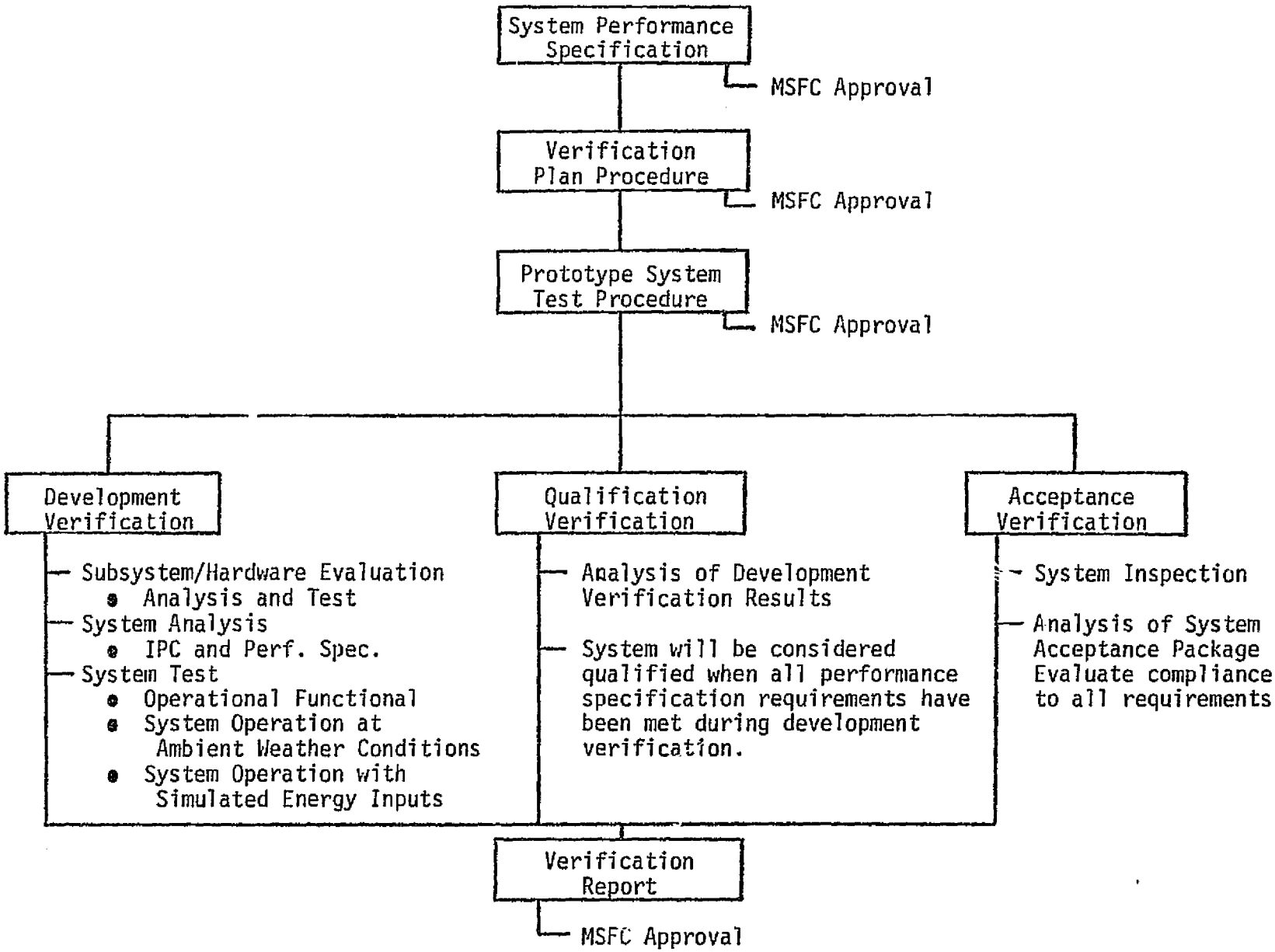

FIGURE I
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APPENDIX I

INTERIM PERFORMANCE CRITERIA

CERTIFICATION FORMS

INTERIM PERFORMANCE CRITERIA

CERTIFICATION

System Type _____

System Model No. _____

System Mfg. _____

Certified by _____
Authorized Representative

Date _____

INTERIM PERFORMANCE CRITERIA CERTIFICATION INSTRUCTIONS

I. Evaluate system for each IPC requirement listed on IPC Certification Sheets. All requirements are to be in accordance with HUD Interim Performance Criteria for Solar Heating and Combined Heating/Cooling Systems and Dwellings. HUD - January 1, 1975.

II. Check each requirement status

Yes - Meets IPC requirement
No - Does not meet IPC requirement
N/A - Requirement not applicable

III. List IPC requirement evaluation method utilized

Analysis
Test
Inspection
Demonstration
Other

IV. All requirements which are not met shall be defined and recorded on IPC Deviation Approval Request (form attached).

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IPC REQUIREMENT	IPC NO.	MEETS IPC		N/A	EVALUATION METHOD	COMMENTS
		YES	NO			
Heating and Heating and Cooling System Performance	1.1					
Hot Water System Subsystem Performance	1.2					
Collector Performance	1.3					
Thermal Storage	1.4					
Habitability of Occupied Space	1.5					
Energy Transport Efficiency	1.6					
Control	1.7					
Auxiliary Energy	1.8					

IPC REQUIREMENT	IPC NO.	MEETS IPC		N/A	EVALUATION METHOD	COMMENTS
		YES	NO			
System Design Conditions	2.1					
Mechanical Stresses	2.2					
Leakage Prevention	2.3					
Collector Adjustment	2.4					
Subsystem Isolation	2.5					
Heat Transfer Fluid Quality	2.6					
Piping Supports	2.7					
Excessive Pressure and Temperature Protection	2.8					

IPC REQUIREMENT	IPC NO.	MEETS IPC		N/A	EVALUATION METHOD	COMMENTS
		YES	NO			
Structural Design Basis	3.1					
Failure Loads and Load Capacity	3.2					
Damage Control	3.3					
Cyclic Loads	3.4					
Cutting of Structural Elements	3.5					
Creep and Residual Deflection	3.6					
Hail Resistance	3.7					
Constraint Loads	3.8					
Ponding Conditions	3.9					

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IPC REQUIREMENT	IPC NO.	MEETS IPC		N/A	EVALUATION METHOD	COMMENTS
		YES	NO			
Plumbing and Electrical Installation	4.1					
Fail Safe Controls	4.2					
Fire Safety	4.3					
Toxic and Flammable Fluids	4.4					
Safety	4.5					
Protection of Potable Water and Circulated Air	4.6					
Excessive Surface Temperatures	4.7					
Effects of External Environment	5.1					

IPC REQUIREMENT	IPC NO.	MEETS IPC		N/A	EVALUATION METHOD	COMMENTS
		YES	NO			
Temperature and Pressure Resistance	5.2					
Chemical Compatibility of Components	5.3					
Components Involving Moving Parts	5.4					
Accessibility for Maintenance	6.1					
Installation, Operation and Maintenance Manual	6.2					
Repair and Service Personnel	6.3					
Dwellings/Facility and Site						

IPC REQUIREMENT	IPC NO.	MEETS IPC		N/A	EVALUATION METHOD	COMMENTS
		YES	NO			
Design	7.1					
Adequate Space	7.2					
Functioning of Dwelling/Facility Site	7.3					
Interference with Mechanical Operation	8.1					
Mechanical and Electrical Functioning of Dwelling and Site	8.2					
Mechanical and Electrical Functioning of Connections	8.3					
Structural Integrity	9.1					
Structural Integrity of Dwelling	9.2					

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IPC REQUIREMENT	IPC NO.	MEETS IPC		N/A	EVALUATION METHOD	COMMENTS
		YES	NO			
Structural Connections	9.3					
Safety of Dwellings and Site	10.1					
Durability	11.1					
Durability and Reliability of Dwelling and Site	11.2					
Durability and Reliability of Connections	11.3					
Maintainability of H, HC, HW Systems	12.1					
Maintainability of Dwelling and Site	12.2					
Connections	12.3					
Visual Characteristics	13.1					

INTERIM PERFORMANCE CRITERIA DEVIATION APPROVAL REQUEST

1. Report Number	2. Date	3. Prepared By	4. Organization	5. System Type
6. System Model No.	7. System S/N	8. System Contractor	9. IPC Deviation	
10. IPC Number	11. IPC Paragraph	12. Approved By (IBM)	13. Approved By (MSFC)	14. Date Approved (MSFC)

15. Description of Deviation

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16. Probable Cause

17. Remarks

18. Deviation Disposition

APPENDIX II

VERIFICATION CROSS REFERENCE MATRIX

ENGINEERING SPECIFICATION

CODE 20234

ITEM (Name & Part No.)

VERIFICATION CROSS REFERENCE MATRIX

Prototype System M/N I

VERIFICATION METHOD:

1. Similarity
2. Analysis
3. Inspection
4. Test

N/N Not Applicable

PERFORMANCE SPECIFICATION REQUIREMENT	VERIFICATION PHASE			REMARKS
	Development	Qualification	Acceptance	
Interim Performance Criteria	2	2		
Government Directed Requirements	2, 3	2, 3	3	
System Identification Requirements	2, 3	2, 3	3	
Site Identification Requirement			3	
System Heating Requirement	2, 4	2		
Auxiliary Energy Requirement	2, 4	2		
Hot Water Requirement	2, 4	2		
Operating Requirements	2, 4	2		
System Physical Requirements	2	2	3	

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CONTRACT NO. NAS8-32036

VERIFICATION SUMMARY

FOR

PROTOTYPE SOLAR ENERGY HEATING AND HOT WATER SYSTEM

MODEL NO. 1A

NOVEMBER 19, 1976

PREPARED BY J. C. Daniel

APPROVED BY V. H. Johnson

1.0 PURPOSE

1.1 The purpose of this document is to present a summary of the verification for Prototype Solar Energy Heating and Hot Water System Model No. 1A.

2.0 SCOPE

2.1 This document provides a summary of Prototype System Model No. 1A verification which includes verification of performance specification requirements and acceptance verification requirements. All requirements of the performance specification will be satisfied by analysis.

3.0 VERIFICATION REQUIREMENTS

3.1 Performance Specification Requirements - Prototype System Model No. 1A shall be in accordance with the requirements of Performance Specification (IBM Document No. 7933444). All requirements will be verified by analysis. Requirements are as follows:

Interim Performance Criteria Requirements

Government Directed Requirements

System Identification Requirement

Site Identification Requirement

System Heating Capacity Requirement

Auxiliary Energy Requirement

Hot Water Requirement

Operating Requirement

System Physical Requirements

3.2 Acceptance Verification Requirements - Prototype System Model No. 1A shall be in accordance with the acceptance verification requirements paragraph 7.0 of IBM Document No. 7933445. Requirements are as follows;

- o Inspection of system to verify performance specification and workmanship standards

- o Inspection of acceptance data package

  - Shipping and handling instructions
  - Installation, Operation and Maintenance Manuals
  - Warranty and Test Agency Certiciation
  - "Final Acceptance" and Shipping Form (DD250) Including forms for all Ship-Separate Items

4.0 VERIFICATION SUMMARY

4.1 Narrative Abstract - Prototype Solar Energy Heating and Hot Water System Model Number 1A was subjected to an analysis verification to verify the requirements of performance specification No. IBM 7933444. Verification was conducted in accordance with the analysis requirements of IBM Document No. 7933445 (Verification Plan/Procedure for Prototype Solar Energy Heating and Hot Water System Model No. 1) . Acceptance verification will be conducted during final acceptance of Prototype System Model No. 1A.

Prototype System Model No. 1A meets all requirements of Performance Specification No. IBM 7933444 with the exception of three (3) interim performance criteria deviations on the system collectors. Deviations are identified in Appendix I of this document.

Verification of prototype system Model 1A will be considered completed with MSFC approval of deviation approval requests for system collectors and with the successful completion of acceptance verification to be conducted during final system acceptance.

4.2 Verification Results

4.2.1 Performance Specification Verification

4.2.1.1 Interim Performance Criteria - Prototype System meets all interim performance criteria requirements with the exception of paragraph 3.2.1 Ultimate Load Combination for Collectors, paragraph 3.3.1 Resistance to Damage for Collectors, and paragraph 5.2.6 Transmission Losses due to Outgassing for Collectors. A deviation from these requirements is requested by IBM since the subject collectors are Government furnished to IBM. Detailed interim performance criteria evaluation is contained in Appendix I of this document.

4.2.1.2 Government Directed Requirements - Requirement has been satisfied by review of performance specification requirements and system design drawings. System 1A meets requirements.

4.2.1.3 System Identification Requirement - Requirement has been satisfied by identification of system in the performance specification (system type, contractor name, system model number). System 1A meets requirements.

4.2.1.4 Site Identification Requirement - Requirement has been satisfied by identifying site location in the performance specification. System 1A meets requirements.

4.2.1.5 System Heating Capacity Requirement - Requirement has been satisfied by analysis of system design System 1A meets requirements.

4.2.1.6 Auxiliary Energy Requirement - Requirement has been satisfied by analysis of system design. System 1A meets requirements.

4.2.1.7 Hot Water Requirement - Requirement has been satisfied by analysis of system design. System 1A meets requirements.

4.2.1.8 Operating Requirements - Requirement has been satisfied by analysis of system design. System 1A meets requirements.

4.2.1.9 System Physical Requirements - Requirement has been satisfied by analysis of system design. System 1A meets requirements.

4.3 Acceptance Verification Requirements

4.3.1 Inspection of System - This requirement will be satisfied during final acceptance of System Model No. 1A.

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4.3.2 Inspection of Acceptance Data Package - This requirement will be satisfied during final acceptance of System Model No. 1A.

5.0 VERIFICATION REPORT

5.1 A final verification report for prototype system Model No. 1A will be prepared and submitted to MSFC thirty days following system acceptance. Report will be prepared in accordance with paragraph 9.2 of IBM Document No. 7933445 except that references to testing and qualification verification will be omitted.

APPENDIX I

PROTOTYPE SYSTEM MODEL NO. 1A

INTERIM PERFORMANCE CRITERIA EVALUATION

INTERIM PERFORMANCE CRITERIA

CERTIFICATION

System Type Heating & Hot Water (Air System)

System Model No. Prototype M/N 1A

System Mfg. IBM

Analysis Conducted by J. G. Daniel

Date NOVEMBER 18, 1976

INTERIM PERFORMANCE CRITERIA CERTIFICATION INSTRUCTIONS

I. Evaluate system for each IPC requirement listed on IPC Certification Sheets. All requirements are to be in accordance with HUD Interim Performance Criteria for Solar Heating and Combined Heating/Cooling Systems and Dwellings. HUD - January 1, 1975.

II. Check each requirement status

Yes - Meets IPC requirement
No - Does not meet IPC requirement
N/A - Requirement not applicable

III. List IPC requirement evaluation method utilized.

Analysis
Test
Inspection
Demonstration
Other

IV. All requirements which are not met shall be defined and recorded on IPC Deviation Approval Request (form attached).

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IPC REQUIREMENT	IPC NO.	MEETS IPC		N/A	EVALUATION METHOD	COMMENTS
		YES	NO			
Heating and Heating and Cooling System Performance	1.1	X			Analysis	Cooling Portion N/A
Hot Water System Subsystem Performance	1.2	X			Analysis	
Collector Performance	1.3	X			Analysis	
Thermal Storage	1.4	X			Analysis	
Habitability of Occupied Space	1.5	X			Analysis	
Energy Transport Efficiency	1.6	X			Analysis	
Control	1.7	X			Analysis	
Auxiliary Energy	1.8	X			Analysis	

IPC REQUIREMENT	IPC NO.	MEETS IPC		N/A	EVALUATION METHOD	COMMENTS
		YES	NO			
System Design Conditions	2.1	X			Analysis	
Mechanical Stresses	2.2	X			Analysis	
Leakage Prevention	2.3	X			Analysis	Applicable portions of system will be pressure tested during system installation
Collector Adjustment	2.4	X			Analysis	
Subsystem Isolation	2.5	X			Analysis	
Heat Transfer Fluid Quality	2.6	X			Analysis	
Piping Supports	2.7	X			Analysis	
Excessive Pressure and Temperature Protection	2.8	X			Analysis	

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TEST REQUIREMENT	IPC NO.	MEETS IPC		N/A	EVALUATION METHOD	COMMENTS
		YES	NO			
Structural Design Basis	3.1	X				
Failure Loads and Load Capacity	3.2					
Ultimate Load Combination	3.2.1		X			No data available to substantiate collector meets requirements
Damage Control	3.3					
Resistance to Damage	3.3.1		X			No data available to substantiate collector meets requirements
Cyclic Loads	3.4					
Cutting of Structural Elements	3.5	X			Analysis	
Creep and Residual Deflection	3.6	X			Analysis	
Hail Resistance	3.7	X			Analysis	
Constraint Loads	3.8					
Ponding Conditions	3.9	X			Analysis	

IPC REQUIREMENT	IPC NO.	MEETS IPC		N/A	EVALUATION METHOD	COMMENTS
		YES	NO			
Plumbing and Electrical Installation	4.1	X			Analysis	
Fail Safe Controls	4.2	X			Analysis	
Fire Safety	4.3	X			Analysis	
Toxic and Flammable Fluids	4.4	X			Analysis	
Safety	4.5	X			Analysis	
Protection of Potable Water and Circulated Air	4.6	X			Analysis	
Excessive Surface Temperatures	4.7	X			Analysis	
Effects of External Environment	5.1	X			Analysis	

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IPC REQUIREMENT	IPC NO.	MEETS IPC		N/A	EVALUATION METHOD	COMMENTS
		YES	NO			
Temperature and Pressure Resistance	5.2	X			Analysis	
Transmission losses due to outgassing	5.2.6		X			No data available to substantiate collector meets requirements
Chemical Compatibility of Components	5.3	X			Analysis	
Components Involving Moving Parts	5.4	X			Analysis	
Accessibility for Maintenance	6.1	X			Analysis	
Installation, Operation and Maintenance Manual	6.2	X			Analysis	
Repair and Service Personnel	6.3	X			Analysis	
Dwellings/Facility and Site						

IPC REQUIREMENT	IPC NO.	MEETS IPC		N/A	EVALUATION METHOD	COMMENTS
		YES	NO			
Design	7.1	X			Analysis	
Adequate Space	7.2	X			Analysis	
Functioning of Dwelling/Facility Site	7.3	X			Analysis	
Interference with Mechanical Operation	8.1	X			Analysis	
Mechanical and Electrical Functioning of Dwelling and Site	8.2	X			Analysis	
Mechanical and Electrical Functioning of Connections	8.3	X			Analysis	
Structural Integrity	9.1	X			Analysis	
Structural Integrity of Dwelling	9.2	X			Analysis	

IPC REQUIREMENT	IPC NO.	MEETS IPC		N/A	EVALUATION METHOD	COMMENTS
		YES	NO			
Structural Connections	9.3	X			Analysis	
Safety of Dwellings and Site	10.1	X			Analysis	
Durability	11.1	X			Analysis	
Durability and Reliability of Dwelling and Site	11.2	X			Analysis	
Durability and Reliability of Connections	11.3	X			Analysis	
Maintainability of H, HC, HW Systems	12.1	X			Analysis	
Maintainability of Dwelling and Site	12.2	X			Analysis	
Connections	12.3	X			Analysis	
Visual Characteristics	13.1	X			Analysis	

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INTERIM PERFORMANCE CRITERIA DEVIATION APPROVAL REQUEST

1. Report Number	2. Date	3. Prepared By	4. Organization	5. System Type
1A-001	11-15-76	T. G. Daniel	IBM Dept. K42	Heating and Hot Water (AIR)
6. System Model No.	**7. System S/N**	**8. System Contractor**	**9. IPC Deviation**	
1A	-	IBM	Ultimate Load Combination (Collectors)	
10. IPC Number	**11. IPC Paragraph**	**12. Approved By (IBM)**	**13. Approved By (MSFC)**	**14. Date Approved (MSFC)**
HUD Jan. 1, 1975	3.2.1			

15. Description of Deviation

No data available to substantitate that collectors meet requirements of ultimate load combinations.

16. Probable Cause

17. Remarks

- Load testing of collectors will be accomplished at MSFC.
- Data received from testing will verify collector ability to meet/not meet IPC requirements for ultimate load combinations.

18. Deviation Disposition

System deviation is requested for collectors.

Collectors are Government furnished to IBM.

INTERIM PERFORMANCE CRITERIA DEVIATION APPROVAL REQUEST

1. Report Number	2. Date	3. Prepared By	4. Organization	6. System Type
IA-002	11-16-76	T. G. Daniel	IBM Dept. K42	Heating and Hot Water (Air)

5. System Model No.	7. System S/N	8. System Contractor	9. IPC Deviation
IA	-	IBM	Resistance to Damage

10. IPC Number	11. IPC Paragraph	12. Approved By (IBM)	13. Approved By (MSFC)	14. Date Approved (MSFC)
IBD Jan. 1, 1975	3.3.1			

15. Description of Deviation

No data available to substantiate that collectors meet requirements of resistance to damage.

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16. Probable Cause

17. Remarks

- Load testing of collectors will be accomplished at MSFC.
- Data received from testing will verify collector ability to meet/not meet IPC resistance to damage requirements.

18. Deviation Disposition

- System deviation is requested for collectors.
- Collectors are Government furnished to IBM.

INTERIM PERFORMANCE CRITERIA DEVIATION APPROVAL REQUEST

1. Report Number	2. Date	3. Prepared By	4. Organization	5. System Type
1A-003	11-16-76	T. G. Daniel	IBM Dept. K42	Heating and Hot Water (Air)

6. System Model No.	7. System S/N	8. System Contractor	9. IPC Deviation
1A	-	IBM	Transmission losses due to outgassing

10. IPC Number	11. IPC Paragraph	12. Approved By (IBM)	13. Approved By (MSFC)	14. Date Approved (MSFC)
IIUD Jan. L, 1975	5.2.6			

15. Description of Deviation

No data available to substantiate that collectors meet requirements of transmission losses due to outgassing.

16. Probable Cause

17. Remarks

- Weathering test will be conducted on collectors at MSFC.
- Data received from testing will verify collector ability to meet/not meet IPC requirements for outgassing.

18. Deviation Disposition

- System deviation requested for collectors.
- Collectors are Government furnished to IBM.

APPENDIX II

PROTOTYPE SYSTEM MODEL NO. 1A

SYSTEM 1 PERFORMANCE ANALYSIS SUMMARY

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SYSTEM I PERFORMANCE ANALYSIS SUMMARY

Evaluation of the System I design was accomplished using a detailed simulation model of the system formulated using TRNSYS-A Transient Simulation Program for Solar Energy Systems. The purpose of this report is to summarize the predicted system performance and the methods used to achieve it.

Each major component of the System I design was modeled in detail resulting in time dependent interaction between the subsystems and producing true system-level performance predictions. The simulation period was one year in duration at integrating time steps of one-fourth hour.

Inputs to the simulation in addition to system configuration and subsystem performance were forcing functions of hourly weather and space heating and hot water load information. Outputs are extensive and include system and subsystem performance such as system temperatures, collector performance, loads, and percent contribution of the solar energy system.

Sensitivity studies were conducted to determine optimum values for several key system parameters:

- System flowrate was varied from 900 to 3000 CFM (1.5 to 5 CFM per square foot of collector). Based on the results, a value of 1500 CFM (2.5 CFM/FT^2c) was chosen.

- The effect of the size of the storage subsystem was evaluated over the range of 150 to 600 FT^3 of pebble bed (5 to 20 BTU/^oF/FT^2c). Results showed that improvement in performance was significant enough to offset additional costs up to 600 FT^3; and the selection of a specific value should be limited only by architectural constraints on the building design. A storage volume of 500 FT^3 (17.9 BTU/^oF/FT^2c) was thus selected.

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- The temperature differential setting controlling collector operation was varied from 25 to 45 F degrees to identify the value giving optimum long term system performance. The resultant value was 30 F degrees.

The optimum values determined from these parametric studies were incorporated into the system design.

The following paragraphs define in somewhat more detail the pertinent parameters and conditions on which the system simulation was based. Finally, the resultant system performance predictions are summarized for the System I design on a monthly and/or yearly basis.

System Configuration

The system simulation schematic is shown in Figure 1. Major components and their defining parameters are listed below.

- Collector
  - Solar Energy Products manufacturer
  - 591 FT^2 effective area
  - 45^o tilt angle
  - 0^o azimuth (due south)
  - Hottel-Whillier-Bliss Motel
  - SEPCO performance data
- Storage
  - 500 FT^3 bed volume
  - 7.2'W x 10.8'L x 6.5'H
  - 17.9 $BTU/^oF/FT^2c$
  - 3/4 - 2 1/2" pebble size
  - R11 Insulation
  - 10 layer model
  - Inside building

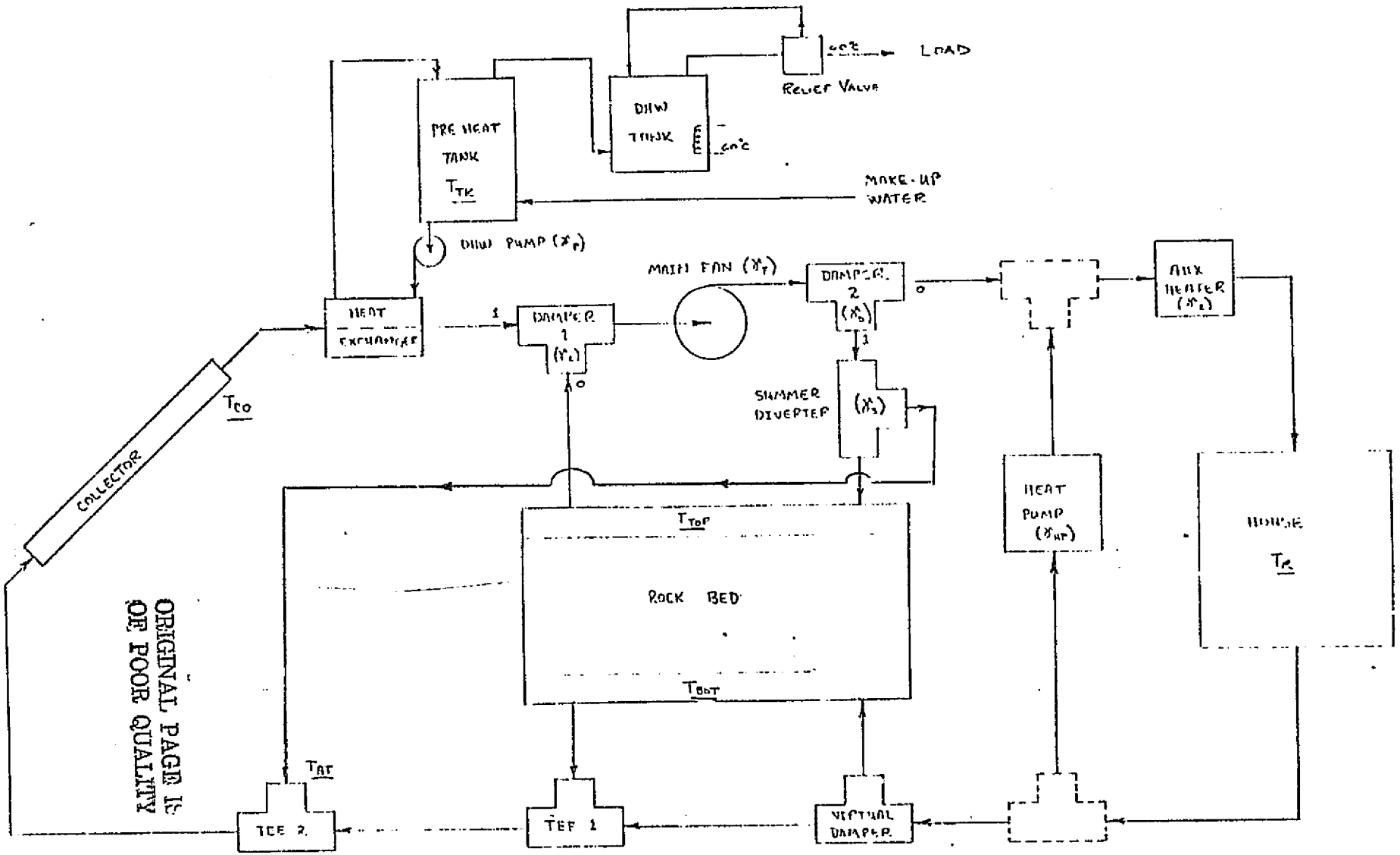

FIGURE 1 SYSTEM SIMULATION SCHEMATIC (TRNSYS)

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- DHW Heat Exchanger
  - Cross flow
  - 725 BTU/HR^{o}F UA
  - 4 GPM water flowrate
- DHW Pump
  - 4 GPM
- DHW Pre-Heat Tank
  - 80 gallons
  - Un-stratified
  - R-22 insulation
- DHW Tank
  - 52 gallons
  - Electrical auxiliary
  - 140^{o}F thermostat
  - Unstratified
  - R-22 insulation
  - 55^{o}F make-up water temperature
- Air Handler
  - 1500 CFM
- Heat-Pump (Air-to-Air)
  - Westinghouse Model HP036D
  - Vendor performance data

- Auxiliary Heater

  - Electric resistance
  - 16.7 KW capacity

- Thermostat

  - First stage heating at room temperature below $68^{\circ}F$
  - Second stage heating at room temperature below $66^{\circ}F$
  - Air conditioning at room temperature above $77^{\circ}F$

- Controls

  - Numerous controllers are used in the simulation to accomplish the required operation. The functional control modes are described below.

  - Collector on (fan turned on) when collector surface temperature exceeds temperature at bottom of storage by 30 F degrees. Collector off (fan off) when collector outlet temperature drops to less than 15 F degrees above bottom of storage. In the summer by-pass mode, the fan operates only when this logic is satisfied and the DHW preheat tank needs heat.

  - DHW pump is turned on whenever the collector is operating and the collector outlet temperature exceeds 9F degrees above preheat tank temperature.

  - The summer bypass mode is initiated at inception of cooling load requirement; disengaged when heating load begins in Fall.

  - When can collect and first stage of room thermostat is satisfied ($T_{ROOM} \geq 68^{\circ}F$ - no requirement for heating) air from collectors is supplied to storage.

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- When can collect and have demand for first stage heat, air from collectors is diverted to load. If in this mode load then demands second stage heat ($T_{ROOM} \leq 66^{o}F$), auxiliary electric strip heater is powered on to supplement.

- When cannot collect and have demand for first stage heat and temperature in top of storage is $\geq 90^{o}F$, heat is supplied from the pebble bed to the load. If in this mode load then demands second stage heat ($T_{ROOM} \leq 66^{o}F$), auxiliary electric strip heater is powered on to supplement.

- When cannot collect and have demand for first stage heat and temperature in top of storage is $<90^{o}F$, the heat pump is powered up. If in this mode load then demands second stage heat ($T_{ROOM} \leq 66^{o}F$), auxiliary electric strip heater is powered on to supplement.

Weather Data

Measured hourly weather data, obtained from the U.S. Weather Bureau, was used as input to the simulation program. This provided a means of analyzing the performance of the system for realistic climatological conditions. Since hourly weather data are not available for Huntsville, data for Nashville for the year 1957 was selected for use as the design year. This year was selected because it approximated the typical winter conditions experienced in Huntsville, Alabama.

Inputs to the program from the weather tapes are hourly values of total insolation on a horizontal surface and the ambient temperature. A solar radiation processor component within the simulation model converts the horizontal insolation values to the proper value incident on the tilted collector surface. The ambient temperature is used in conjunction with the building conductance (UA) and the inside room temperature to actively determine the heat loss rate. For information only, the average daily insolation for each month and a computed value of the heating degree (^{o}F) days per month are provided in Table I.

Table I. Summary of Weather Data

Month	Insolation on Horizontal Surface (BTU/FT^2) - Avg daily	Heating Degree Days ($^{\circ}$F)
January	597	847
February	834	506
March	1136	530
April	1635	188
May	1833	67
June	1882	3
July	2176	1
August	2071	8
September	1360	35
October	1136	305
November	821	492
December	702	612

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Heating and Hot Water Loads

The space heating and service hot water loads are handled independently in the system model. The space heating load is modeled as a single node with a thermal capacitance of 2.1×10^4 BTU/^{o}F and a heat loss rate (UA) of 750 BTU/Hour-^{o}F. The internal temperature was maintained during the heating season with a two stage thermostat. The thermostat settings were 68^{o}F and 66^{o}F for the first and second stages respectively. The hourly heating load of the building (Q_L) is expressed in the following equation:

$$Q_L = UA\ (T_R - T_{amb})$$

where UA = 750 BTU/Hour - ^{o}F

T_R = Inside temperature (^{o}F)

T_{amb} = Ambient temperature (^{o}F)

The hot water load is established by a daily usage schedule. This schedule is defined on a hourly basis with the outlet water at 140^{o}F and the inlet at 55^{o}F. A total of 41.5 gallons per day was established for this particular site. For a residentual application, this would typically be doubled. The following table presents the daily usage schedule on an hourly basis:

Table II. Daily Hot Water Consumption

Hour of Day	Gallons/Hour
0-7	0
7-8	2.5
8-9	5
9-10	2.5
10-11	12.5
11-12	0
12-13	2.5
13-14	0
14-16	1
16-18	0
18-20	2.5
20-21	7. 5
21-23	1
23-24	0

A listing of the input data for the TRNSYS System I model is shown in Table III.

Performance Results

The results of the one-year simulation are presented graphically in Figure 2 through 4 for each month. As shown:

- The annual contribution of the solar energy system to the space heating load is 58%.
- The annual contribution of the solar energy system to the domestic hot water load is 57%.
- The annual contribution of the solar energy system to the overall load is 58%.

It should be noted that these results are highly dependent on a number of assumed input conditions, including weather. Although the conditions used for this simulation are typical, significant variations can occur.

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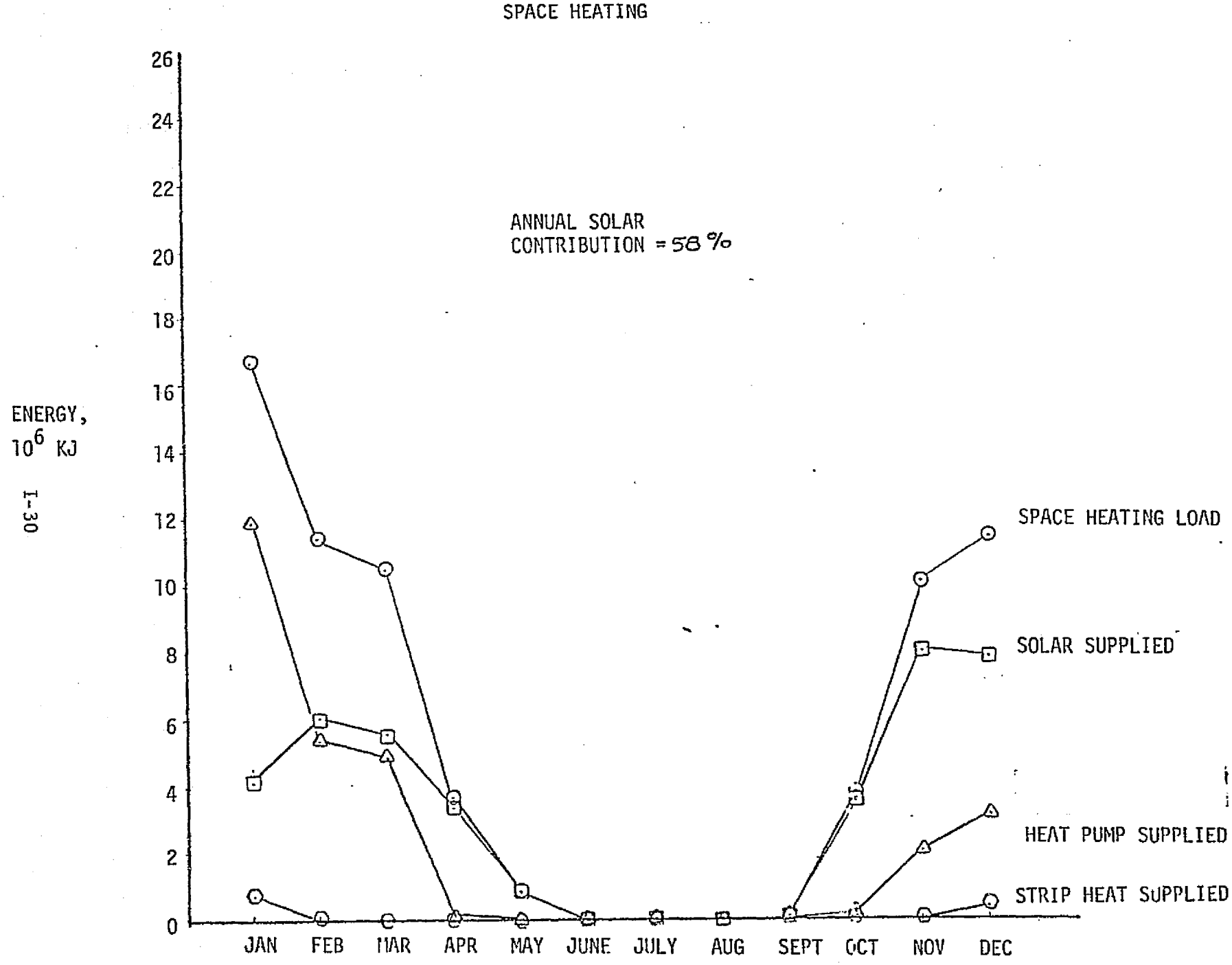
SPACE HEATING
ANNUAL SOLAR
CONTRIBUTION = 58 %
ENERGY,
10^6 KJ
26
24
22
20
18
16
14
12
10
8
6
4
2
0
JAN
FEB
MAR
APR
MAY
JUNE
JULY
AUG
SEPT
OCT
NOV
DEC
SPACE HEATING LOAD
SOLAR SUPPLIED
HEAT PUMP SUPPLIED
STRIP HEAT SUPPLIED

FIGURE 2

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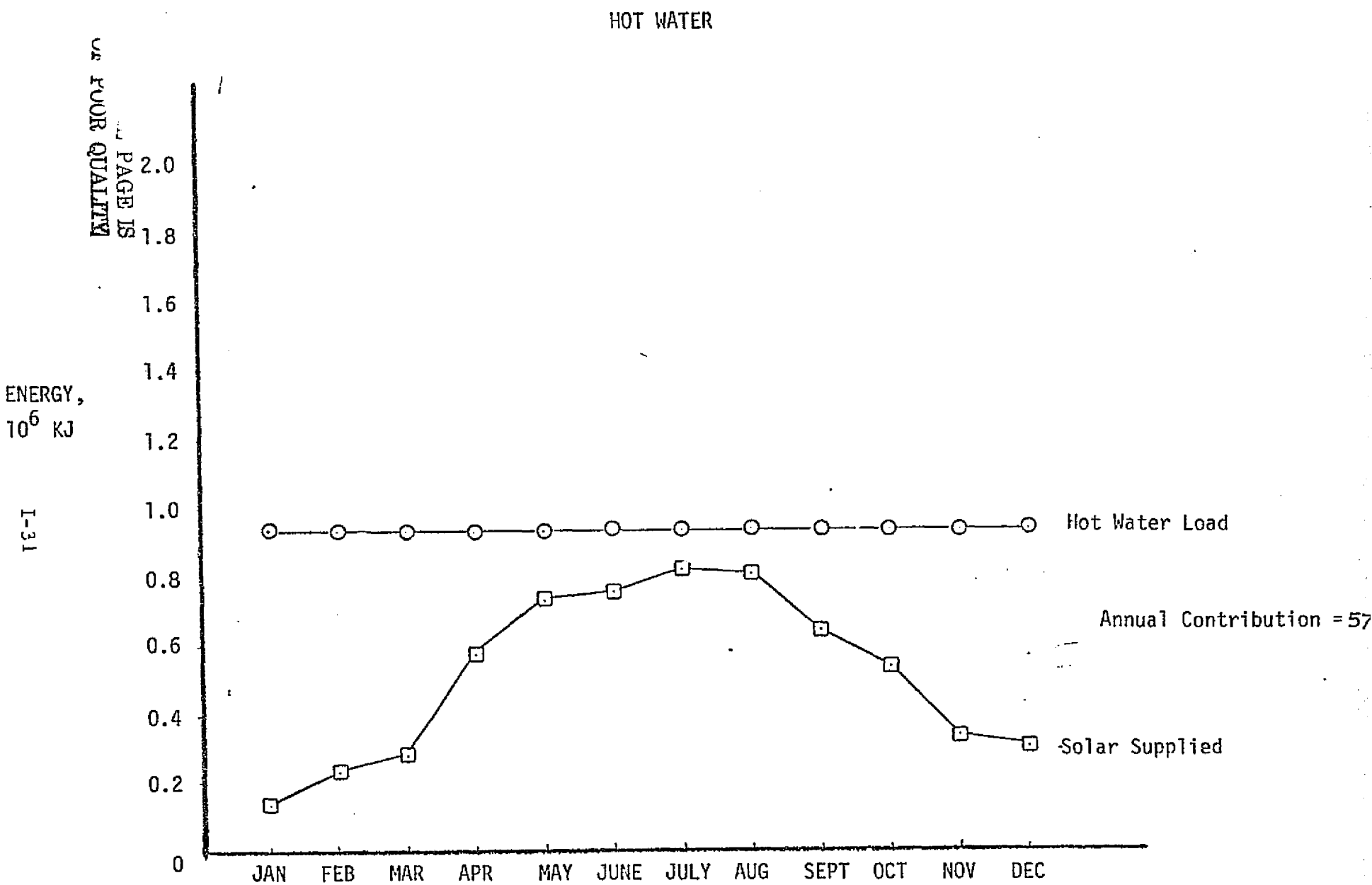

FIGURE 3

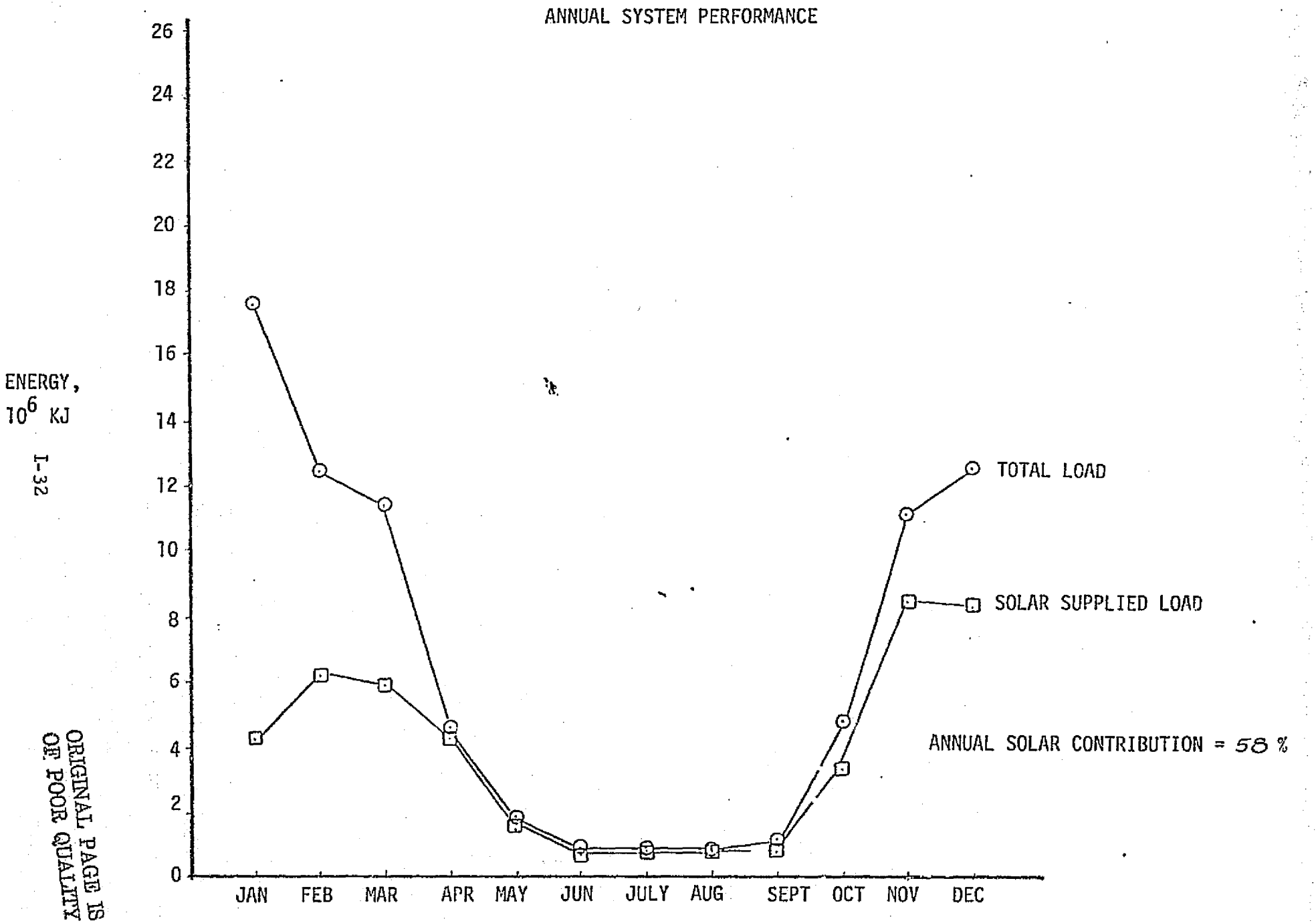

FIGURE 4

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TABLE III

```
TRNSYS - A TRANSIENT SIMULATION PROGRAM
FROM THE SOLAR ENERGY LAB / THE UNIVERSITY OF WISCONSIN
VERSION  5   6/1/76

SIMULATION          0.0          7.200E 02     2.500E-01
WIDTH  72
MAP
LIMITS  25  20
TOLERANCES          -2.000E-01   -2.000E-01
**********************************************************************
*                                                                    *
*          SYSTEM IA  PERFORMANCE SENSITIVITY STUDY                  *
*                                                                    *
*          P A R A M E T E R          V A L U E                      *
*                                                                    *
*     A. COLLECTOR CONTROL DELTA T    25   35   45   FDEG           *
*     B. STORAGE CAPACITY              5   10   15   BTU/F/FT2      *
*     C. FLOWRATE                    1.5    2  2.5   GPM/FT2        *
*                                                                    *
*                    RUN NUMBER  25                                  *
*                      A    B    C                                   *
*                    30F  17.9  2.5                                  *
*                                                                    *
**********************************************************************
UNIT  9     TYPE  9     CARD READER
PARAMETERS  6
9.000E 00    1.000E 00    5.000E 00    5.556E-01    -2.730E 02
6.000E 00    1.135E 01    0.0
UNIT 16     TYPE 16     RADIATION PROCESSOR
PARAMETERS  7
1.000E 00    1.000E 00    3.600E 01    4.500E 01    0.0
4.870E 03    2.000E-01
INPUTS  1
 9,  8
0.0
UNIT  1     TYPE  1     AIR COLLECTOR (MODE 1)
PARAMETERS  7
1.000E 00    5.500E 01    9.000E-01    1.012E 00    9.200E-01
2.660E 01    8.500E-01
INPUTS  4
42,  1       42,  2       9,  5        16,  1
```

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```
                                    (CONT.)
        2.000E 01       0.0             0.0             0.0

UNIT  2     TYPE  2     COLLECTOR CONTROLLER                    **********
        PARAMETERS  3
        3.000E 00       1.670E 01       8.3 0E 00
        INPUTS  3
         1, 1           10, 1           2, 1
        2.000E 01       2.000E 01       0.0

UNIT 11     TYPE 11     DAMPER NO. 1
        PARAMETERS  1
        3.000E 00
        INPUTS  5
        10, 3           10, 4           43, 1           43, 2           2, 1
        3.300E 01       0.0             3.300E 01       0.0             0.0

UNIT 43     TYPE  5     DHW HEAT EXCHANGER
        PARAMETERS  4
        3.000E 00       1.378E 03       1.012E 00       4.190E 00
        INPUTS  4
         1, 1           1, 2            44, 1           44, 2
        2.500E 01       0.0             2.500E 01       0.0

UNIT  5     TYPE 21     DHW PUMP CONTROLLER (AND/OR)
        PARAMETERS  2
        1.000E 00       1.000E 00
        INPUTS  8
         1, 1           45, 3           0, 0            0, 0            45, 3
         0, 0           0, 0            0, 0
        2.500E 01       2.500E 01       -5.000E 00      0.0             2.500E 01
        1.000E 03       1.000E 00       3.200E 01

UNIT 44     TYPE  3     DHW PUMP
        PARAMETERS  1
        9.040E 02
        INPUTS  3
        45, 1           45, 2           36, 1
        2.500E 01       0.0             0.0

UNIT 45     TYPE  4     TANK1 (PRE-HEAT)
        PARAMETERS  5
        3.000E-01       1.730E 00       4.190E 00       1.000E 03       3.250E 00
        INPUTS  5
        43, 3           43, 4           0, 0            47, 1           12, 4
        2.500E 01       0.0             1.260E 01       0.0             2.500E 01
        DERIVATIVES  1
        3.500E 01

UNIT  7     TYPE 13     RELIEF VALVE , HOT WATER DELIVERY TEMP CONTRO
        PARAMETERS  2
        6.000E 01       4.190E 00
        INPUTS  3
        46, 3           46, 4           46, 3
        2.500E 01       0.0             2.500E 01

UNIT  6     TYPE 15     AL OF HW EXCESS HEAT RETURN
        PARAMETERS  9
        0.0             0.0             0.0             0.0             1.000E 00
        0.0             2.000E 00       2.000E 00       3.000E 00
        INPUTS  5
        45, 3           7, 3            7, 2            0, 0            0, 0
```

TABLE III (CONT)

```
        2.500E 01     0.0                0.                 4.190E 00     1.000E-03
UNIT 46     TYPE  4        TANK 2  (HW)
PARAMETERS  9
 2.000E-01     1.220E 00     4.180E 00     1.000E 03     3.250E 00
 1.620E 04     1.000E 00     1.000E 00     6.000E 01
INPUTS  6
 0, 0          0, 0          0, 1          45, 4         12, 4
 0.0           0.0           2.500E 01     0.0           2.500E 01
 1.000E 00
DERIVATIVES  1
 6.000E 01

UNIT 47     TYPE 14        HOT WATER - USE PROFILE (L      GAL/DAY)
PARAMETERS 56
 0.0           0.0           7.000E 00     0.0           7.000E 00
 9.420E 00     8.000E 00     9.420E 00     8.000E 00     1.890E 01
 9.000E 00     1.890E 01     9.000E 00     9.420E 00     1.000E 01
 9.420E 00     1.000E 01     4.710E 01     1.100E 01     4.710E 01
 1.100E 01     0.0           1.200E 01     0.0           1.200E 01
 9.420E 00     1.300E 01     9.420E 00     1.300E 01     0.0
 1.400E 01     0.0           1.400E 01     3.700E 00     1.500E 01
 3.700E 00     1.600E 01     0.0           1.800E 01     0.0
 1.800E 01     9.420E 00     2.000E 01     9.420E 00     2.000E 01
 2.830E 01     2.100E 01     2.830E 01     2.100E 01     3.700E 00
 2.300E 01     3.700E 00     2.300E 01     0.0           2.400E 01
 0.0

UNIT 30     TYPE 15        HOT WATER SUPPLIED CALCULATOR
PARAMETERS  7
 0.0           0.0           0.0           0.0           4.000E 00
 1.000E 00     1.000E 00
INPUTS  4
 47, 1         0, 0          7, 1          0, 0
 0.0           4.190E 00     6.000E 01     1.280E 01

UNIT 37     TYPE 15        CALCULATE QHWSOL
PARAMETERS  3
 0.0           0.0           4.000E 00
INPUTS  2
 24, 1         24, 2
 0.0           0.0

UNIT 14     TYPE 15        FAN CONTROLLER
PARAMETERS 13
-1.000E 00     1.000E 00     0.0           4.000E 00    -1.000E 00
 1.000E 00     0.0           4.000E 00     1.000E 00     7.000E 00
-1.000E 00     1.000E 00     3.000E 00
INPUTS  2
 2, 1          31, 1
 0.0           0.0

UNIT 17     TYPE 15        FAN CONTROLLER INHIBIT LOGIC #1
PARAMETERS  5
 0.0           0.0           0.0           4.000E 00     1.000E 00
INPUTS  3
 14, 1         0, 0          40, 1
 0.0           1.000E 00     0.0

UNIT 18     TYPE 15        FAN CONTROLLER INHIBIT LOGIC #2
```

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```
        PARAMETERS  3
        0.0             0.0             1.0 00 00
        INPUTS  2
         5, 1           40, 1
        0.0             0.0

UNIT 41     TYPE 15     FAN CONTROLLER INHIBIT LOGIC #3
        PARAMETERS  3
        0.0             0.0             3.000E 00
        INPUTS  2
        17, 1           18, 1
        0.0             0.0

UNIT  3     TYPE  3     MAIN FAN                    **********
        PARAMETERS  1
        2.779E 03
        INPUTS  3
        11, 1           11, 2           14, 1
        3.300E 01       0.0             0.0

UNIT 31     TYPE 15     DAMPER NO.2 CONTROLLER              **********
        PARAMETERS  4
        0.0             -1.000E 00      2.779E 03       2.000E 00
        INPUTS  1
        20, 2
        0.0

UNIT 21     TYPE 11     DAMPER NO. 2
        PARAMETERS  1
        2.000E 00
        INPUTS  3
         3, 1           3, 2            31, 1
        3.300E 01       0.0             0.0

UNIT 40     TYPE  2     SUMMER BY-PASS CONTROLLER
        PARAMETERS  3
        4.000E 00       5.000E 00       0.0
        INPUTS  3
        12, 4           0, 0            40, 1
        2.000E 01       2.000E 01       0.0

UNIT 41     TYPE 11     BY-PASS DIVERTER
        PARAMETERS  1
        2.000E 00
        INPUTS  3
        21, 1           21, 2           40, 1
        2.500E 01       0.0             0.0

UNIT  4     TYPE 15     ATTIC TEMPERATURE
        PARAMETERS  7
        0.0             0.0             1.000E 00       0.0             0.0
        1.000E 00       3.000E 00
        INPUTS  4
         9, 5           0, 0            1, 1            0, 0
        2.500E 01       8.500E-01       2.500E 01       1.500E-01

UNIT 42     TYPE 11     BY-PASS TEE
        PARAMETERS  1
        1.000E 00
        INPUTS  4
        22, 1           22, 2           41, 3           41, 4
```

TABLE II (CONT)

```
        2.500E 01     0.0           2.5 0E 01     0.0

UNIT 10     TYPE 10     ROCK BED          **********
PARAMETERS  8
1.012E 00     1.930E 00     7.  0E 00     1.096E 01     8.800E-01
1.600E 03     1.630E 00     4.  0E-01
INPUTS  5
41, 1         41, 2         23, 1         23, 2         12, 4
2.000E 01     0.0           2.000E 01     0.0           2.000E 01
DERIVATIVES 10
4.000E 01     3.700E 01     3.500E 01     3.300E 01     3.100E 01
2.900E 01     2.700E 01     2.500E 01     2.300E 01     2.000E 01

UNIT 22     TYPE 11     TEE-PIECE
PARAMETERS  1
1.000E 00
INPUTS  4
10, 1         10, 2         23, 3         23, 4
2.000E 01     0.0           2.000E 01     0.0

UNIT 32     TYPE 15     AL OP, QU POSITIVE ONLY
PARAMETERS  2
0.0           8.000E 00
INPUTS  1
 1, 3
0.0

UNIT 33     TYPE 15     LOAD CALCULATOR    '750 BTU/HOUR-F'
PARAMETERS  6
0.0           0.0           4.000E 00     -1.000E 00     1.425E 03
1.000E 00
INPUTS  2
 9, 5         12, 4
2.000E 01     0.0

UNIT 34     TYPE 15     COOLING LOAD
PARAMETERS  2
0.0           8.000E 00
INPUTS  1
33, 1
0.0

UNIT 35     TYPE 15     HEATING LOAD
PARAMETERS  3
0.0           7.000E 00     8.000E 00
INPUTS  1
33, 1
0.0

UNIT 38     TYPE 15
PARAMETERS  3
0.0           0.0           3.000E 00
INPUTS  2
33, 1         10, 7
0.0           0.0

UNIT 39     TYPE 15
PARAMETERS  1
3.000E 00
INPUTS  2
 8, 1         8, 3
```

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```
        0.0             0.0

UNIT 20     TYPE 20     AIR TO AIR HEAT PUMP
     PARAMETERS 17
     1.012E 00      2.779E 03      2.0 0E 01      2.500E 01      1.000E 03
    -1.000E 01      1.000E 01      5.0 0E 00      7.000E 00      6.000E 00
     2.200E 01      2.223E 03      1.000E 00      3.200E 01      1.000E 00
     2.100E C1      0.0
     INPUTS  6
      3, 1           21, 4           9, 5           38, 1          39, 1
     12, 4
     2.000E 01      0.0             0.0            0.0            0.0
     0.0

UNIT 23     TYPE 11     VIRTUAL DAMPER
     PARAMETERS  1
     2.000E 00
     INPUTS  3
     20, 1          20, 2           2, 1
     2.000E C1      0.0             0.0

UNIT 15     TYPE 15     HEAT ADDER
     PARAMETERS 13
     0.0            0.0             0.0            0.0            0.0
     0.0            0.0             4.000E 00      3.000E 00      3.000E 00
     3.000E C0      3.000E 00       3.000E 00
     INPUTS  7
     33, 1          29, 1           20,15          20, 9          20, 5
     10, 7          20,12
     0.0            0.0             0.0            0.0            0.0
     0.0            0.0

UNIT 12     TYPE 12     ONE-NODE HOUSE
     PARAMETERS  9
     4.000E 00      0.0             4.000E 04      0.0            1.000E 00
     1.000E 00      1.000E 00       0.0
     INPUTS  4
      0, 0           0, 0            9, 5           15, 1
     0.0            0.0             0.0            0.0
     DERIVATIVES  1
     2.000E 01

UNIT  8     TYPE  8     THREE STAGE ROOM THERMOSTAT
     PARAMETERS  6
     5.000E 00      1.000E 00       0.0            2.500E 01      2.000E 01
     1.900E 01
     INPUTS  2
     12, 4           0, 0
     2.000E C1      1.000E 02

UNIT 29     TYPE 15     AUX FURNACE
     PARAMETERS  1
     1.000E 00
     INPUTS  2
      6, 2           0, 0
     0.0            6.000E 04

UNIT 36     TYPE 15     PUMP TIME 'AND' FUNCTION
     PARAMETERS  3
     0.0            0.0             1.000E 00
     INPUTS  2
```

TABLE II Cont

```
        46, 1           5,
        0.0             0.0

UNIT 24     TYPE 24     INTEGRATOR 1
        PARAMETERS  1
        7.200E 02
        INPUTS  10
        30, 1           46, 9           37, 1           20, 3           29, 1
        20,15           3?, 1           16, I           3?, 1           ?, 1
        0.0             ?.?             0.0             0.0             0.0
        0.0             ?.?             ?.?             0.0             0.0

UNIT 19     TYPE 24     INTEGRATOR 2
        PARAMETERS  1
        7.200E 02
        INPUTS  7
        36, 1           10, 2           10, 4           31, 1           10, 6
        20,12           20,14
        0.0             0.0             0.0             0.0             0.0
        0.0             0.0

UNIT 50     TYPE 24     INTEGRATOR 3
        PARAMETERS  1
        7.200E 02
        INPUTS  5
        16, 2           16, 3           16, 4           16, 5           16, 6
        0.0             0.0             0.0             0.0             0.0

UNIT 27     TYPE 25     PRINTER 3
        PARAMETERS  1
        7.200E 02
        INPUTS  5
        50,             50, 2           50, 3           50, 4           50, 5
        HBTILT          HDTILT          HTHORZ          HBHORZ          HDHORZ

UNIT 25     TYPE 25     PRINTER 1
        PARAMETERS  1
        7.200E 02
        INPUTS  10
        24, 1           24, 2           37, 1           24, 4           24, 5
        24, 6           24, 7           24, 8           24, 9           24,10
        QHWSUP          QAUXHW          QHWSOL          QDH             QAJXH
        QR2             QU              HTILT           WAH             FANTIM

UNIT 26     TYPE 25     PRINTER 2
        PARAMETERS  1
        7.200E 02
        INPUTS  7
        19, 1           19, 2           19, 3           19, 4           19, 5
        19, 6           19, 7
        PUNTIM          COLSTO          STOLOD          SOLLOD          QBED
        QAC             WAC

UNIT 13     TYPE 26     PLOTTER
        PARAMETERS  4
        7.200E 02       0.0             8.640E 03       1.000E 00
        INPUTS  5
        37, 1           24, 1           24, 4           24, 5           24, 6
        QHWSOL          QHWSUP          QDH             QAUXH           QR2

END
```

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PROTOTYPE SYSTEM 1
HAZARDS ANALYSIS

November 1976

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PROTOTYPE SYSTEM NO. 1
HAZARDS ANALYSIS

A hazards analysis was performed to define potential hazards or undesired events relative to the System No. 1 design, to identify the safety requirement to eliminate the hazard, and to indicate the means of compliance with each safety requirement. A summary of the hazards analysis results are given in Table 1.

All potential hazards identified are minor level hazards and no major hazard levels have been found. No residual hazards have been identified, and no failure modes have been identified which would contribute to the occurrence of a hazard. As shown in Table 1, the use of standard off-the-shelf hardware minimizes potential hazards.

HAZARD DATA SUMMARY

Areas of Consideration	Safety Requirement	Hazard/Undesired Event	Means of Compliance
Mechanical Protection	• Mechanical Hazards not significantly greater than conventional residence.	• Injury due to pinch or sharp edges.	• All operator and service area edges rounded.
		• Short circuits due to wire abrasion.	• Design does not present unusual or unique mechanical hazards.
		• Mechanical damage due to faulty installation.	• Approved tie down, strain relief and feed through hardware and installation.
		• Mechanical damage due to migration of components during operation	• Drawings provided with sufficient design detail and notes to highlight proper installation.
		• Rotating Equipment	• Motor, Belt and Fan enclosed
			• DHW Pump has all rotating parts enclosed.
		• Humidity and Fungus	• All equipment mounted within the residence.

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HAZARD DATA SUMMARY

Areas of Consideration	Safety Requirement	Hazard/Undesired Event	Means of Compliance
Primary Voltages	• Section 516 and 616 MPS (4900.1 and 4910.1). • Part E of ANSI A119.1 • Hazard exposure not significantly greater than conventional residence.	• Personnel Shock • Equipment damage due to short circuit or overload.	• Use conventional equipment and installation. • All external metal parts, surfaces and shields to be at electrical ground. • UL approved 15A circuit breaker • All wire UL approved • Primary voltage in service areas are protected by shields or shrink sleeve insulation.
		• Stored Energy	• Stored energy minimal • Low voltage control circuit
Secondary Voltages		• Short between primary and secondary circuits	• Transformer isolation and physical separation between primary and secondary circuits.
Electromagnetic Interference	• Maintain circuit separation	• Interference between power, data and control functions	• Sensor and control wires separated. Sensor inputs are protected by ground wires for each channel.

HAZARD DATA SUMMARY

Areas of Consideration	Safety Requirement	Hazard/Undesired Event	Means of Compliance
Fire Safety	• Use materials which do not present a fire hazard significantly greater than conventional systems	• Flammability of materials	• Used conventional components of proven safety
		• Air flow loss due to fan failure or blockage	• UL recognized components as • UL acceptance of air handler and control subsystems
	• Proper clearance and venting of elevated temperature surface		• Interlocks to insure fan operation when heat strips in use
	• Emergency egress and access not be less than conventional system	• Occupant entrapment	• Conventional design criteria met for egress and access. Convenient and accessible equipment room
	• Identified and accessible main shut-off valves and switches	• Difficulty in terminating system operation or isolating failure	• Main shutoff valves and switches are clearly labeled and easily accessible within equipment room

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HAZARD DATA SUMMARY

Areas of Consideration	Safety Requirement	Hazard/Undesired Event	Means of Compliance
Domestic Hot Water	• Where applicable Section 515 and 615 MPS (4900.1 and 4910.1)	• Personnel exposure to high temperatures	• Used commercially available DHW tanks, pumps and heat exchanger of proven design
	• Part C ANSI A119.1	• Personnel exposure to high pressures	• Automatic 210°F temperature and 150 PSI pressure relief valve
	• Hazards not significantly greater than conventional residential installation	• Equipment damage	• Stainless steel potable rated DHW pump
			• Fail Safe DHW temperature control on both water tanks
			• Insulated heat exchanger and connecting pipes
		• Contamination of potable water	• Non potable fluid not used
Control		• Primary 115 Volt Shock	• Safety shield used over primary terminal and shrink sleeving used on 115V wire terminals within service area.
		• Shorts from primary 115V to 24V control circuits	• Primary and control voltages transformer isolated with wiring physically separated
		• Damage to collector by over temperature	• Collector temperature protect mode for summer operation
	• Fail Safe control	• Control failures	• Autonomous temperature limits and interlocks within control circuits

HAZARD DATA SUMMARY

Areas of Consideration	Safety Requirement	Hazard/Undesired Event	Means of Compliance
Air Handler	• Section 516 and 616 MPS (4900.1 and 4910.1)	• Primary 115 Volt Shock	• Primary 115 Volt circuit terminations enclosed
	• Part C ANSI A119.1		• Over temperature protected motor
	• UL acceptance	• Toxic or Flammable materials	• UL approved wire nuts
			• Use commercial components of proven design
			• Independent review of material hazards
			• UL acceptance of the completed air handler and controller assembly
		• Rotating Equipment entanglement	• Fan, motor and belt totally enclosed
Auxiliary Heat			• Use conventional equipment of proven design and installation
		• Electrical Shock	• Primary power terminations enclosed
		• Fire hazard if air flow interrupted	• Control interlocks between fan and heat strips
		• Excessive surface temperatures	• Positive action air flow velocity switch interlock
			• Heater installed in insulated duct

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